The Dock & Harbour Authority

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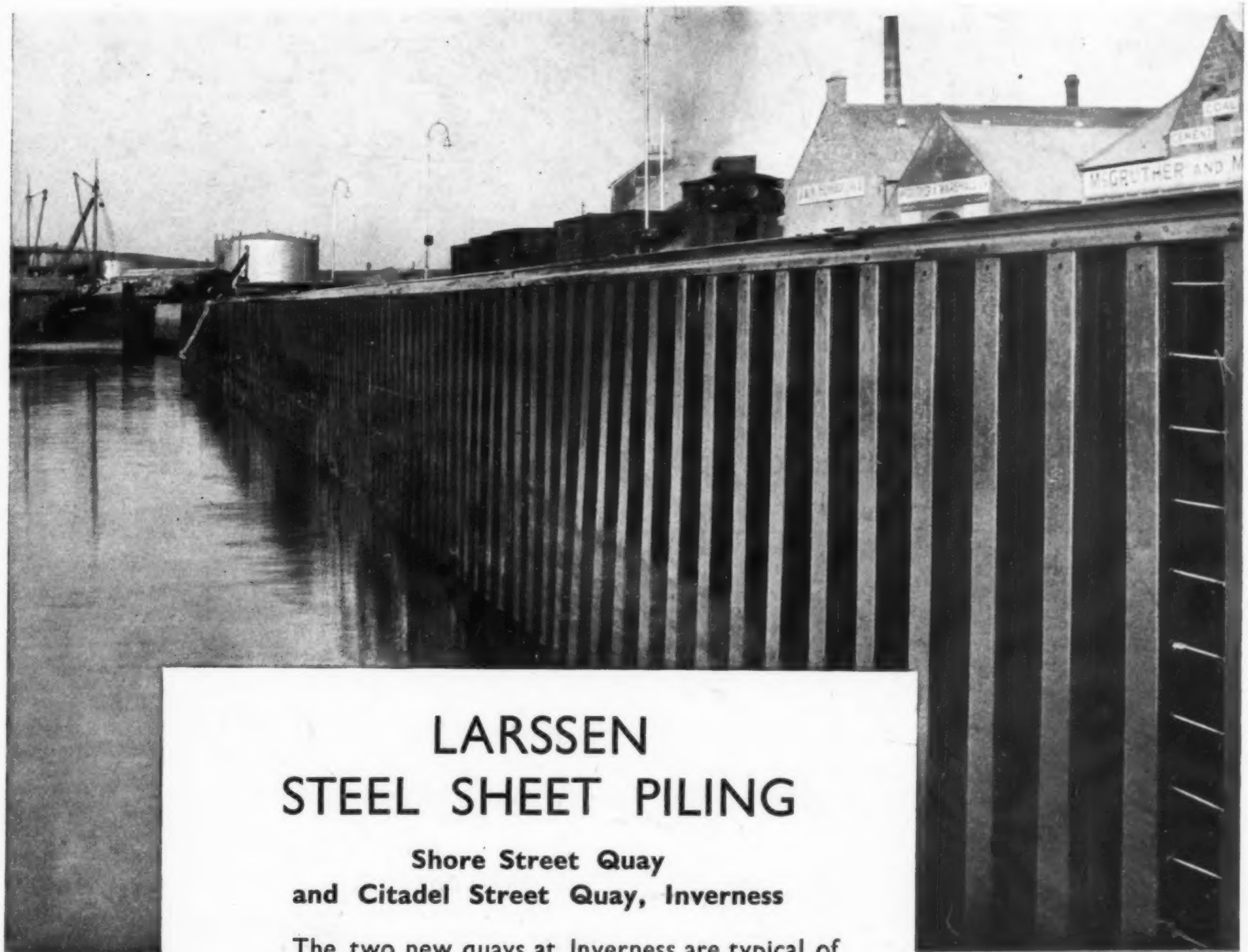

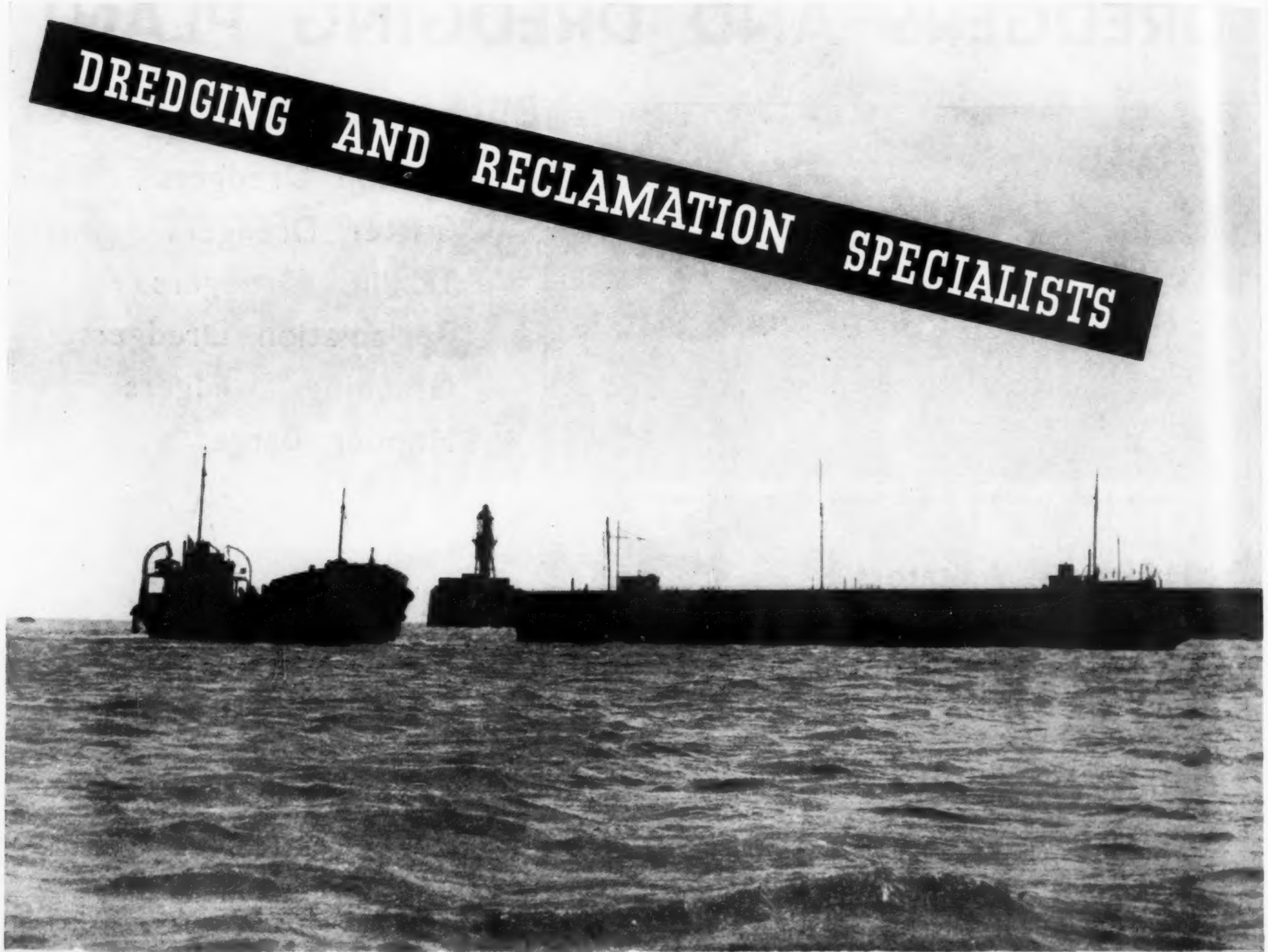

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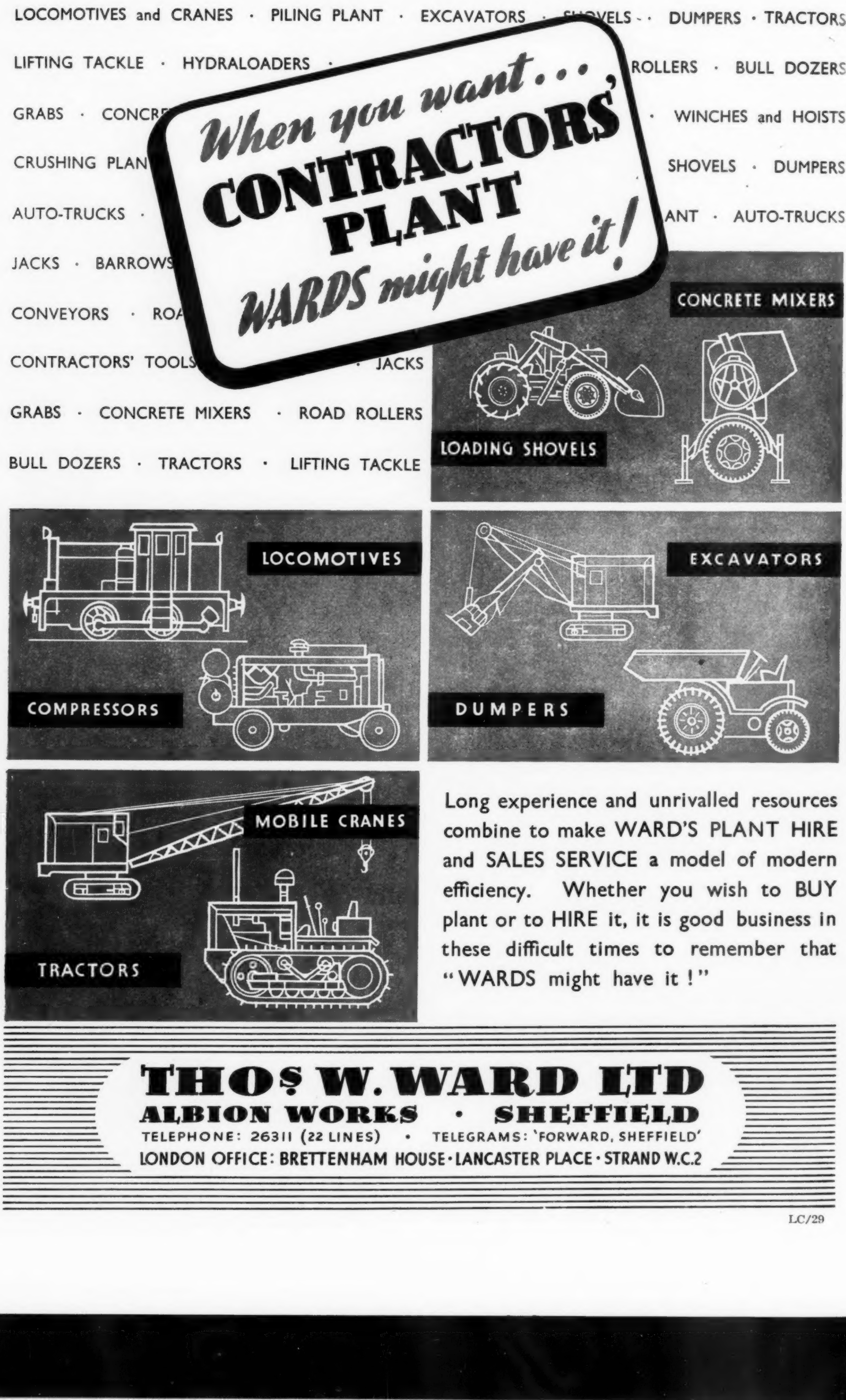
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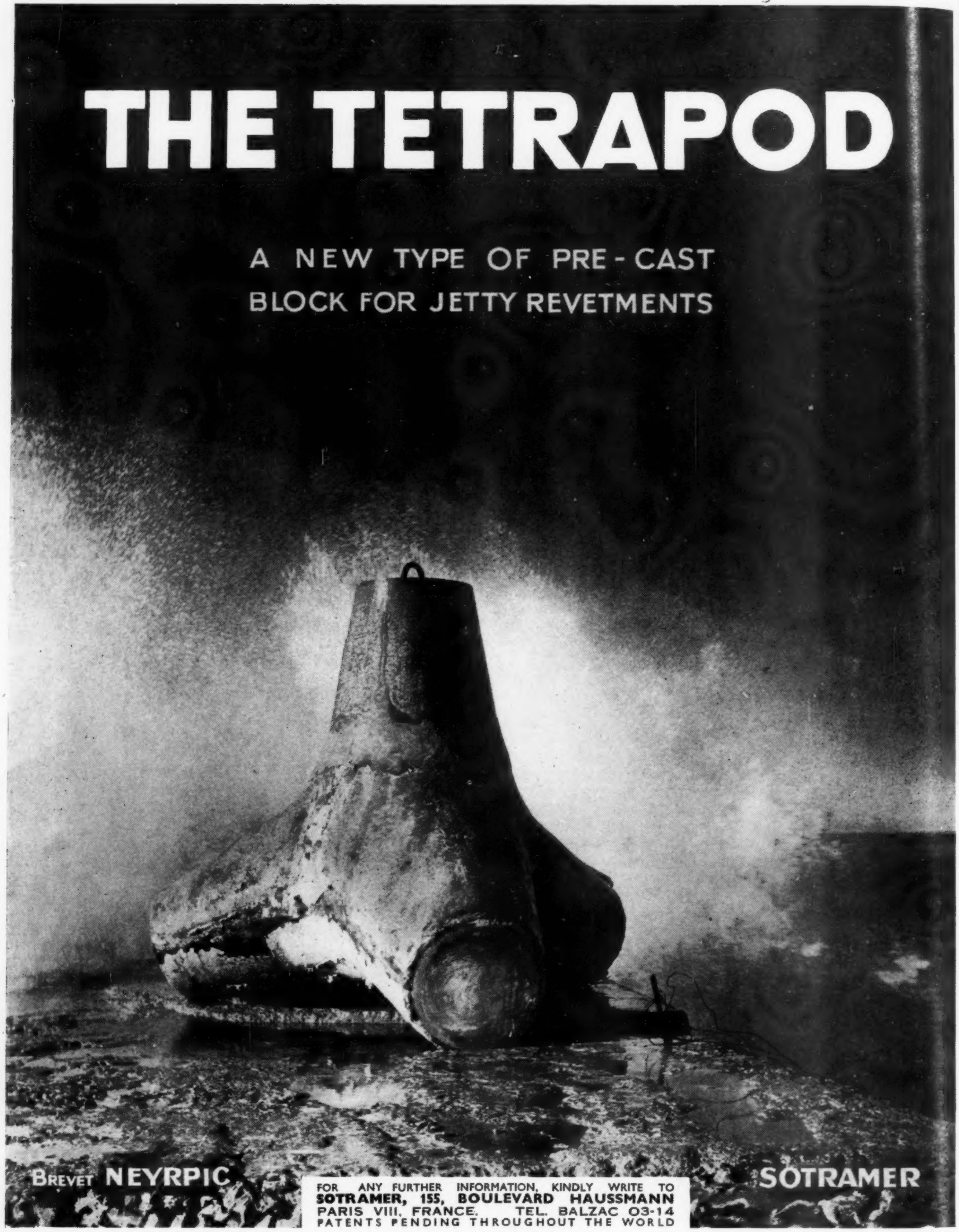

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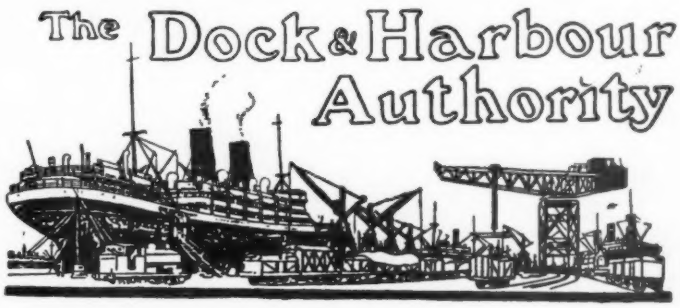

To Correspondents

All Letters and Contributions intended for Publication should be addressed to the Editor:—
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CONTENTS

The Dock and Harbour Authority

No. 381. Vol. XXXIII JULY, 1952 Monthly 2s. 0d

Editorial Comments

The Amsterdam-Rhine Canal.

The formal opening by Queen Juliana of Holland on 21st May last of the great Tiel Lock, inaugurating the new Amsterdam-Rhine Canal, marks the conclusion of a project first authorised in 1931, in response to the ever-growing demand for quicker communications and facilities for larger vessels.

With the opening of the Canal, Amsterdam has become the nearest seaport to the Swiss, German and French industrial districts bordering the River Rhine, and it is expected that the new waterway will carry 50 million tons of inland shipping, compared with the 23 million tons transported last year along the old route.

The movement of cargo between Amsterdam and the Rhine can be traced back to the 15th century, but in those days vessels travelled by long circuitous routes, which, however, proved to be adequate until the last century, when the Merwede Canal was constructed. From Amsterdam to Utrecht, the new canal follows the old route, which is being widened. From Utrecht, the canal has been cut via Wijk-bij-Duurstede and Ravensway to Tiel, where it joins the Waal, the main arm of the Rhine.

The leading article in this issue describes in considerable detail the physical, engineering and economic aspects of this important link in the inland waterways of the Continent, and readers will observe many points of interest. For example, the lock at Tiel, which is over 1,180 feet in length and is the largest inland lock in the world, is one of the greatest achievements in the construction of the canal. It is monolithic in form and is founded on piles due to the poor quality of the sub-soil.

In connection with the locks on the new canal, it is worth remark that, whereas on the old route between Amsterdam and the Waal, no less than four locks had to be negotiated, there are now normally only two separating the Port of Amsterdam from the Rhine.

Among other interesting features of the Canal are the methods adopted for crossing the River Lek; by means of groynes its waters are passed through the canal without navigational interference or siltation.

Amsterdam is one of the four great ports—Rotterdam, Antwerp and Ghent being the others—which form the gateway to Europe through a system of waterways having as its backbone the Rhine, which is the lifeline of the most densely populated and highly industrialised regions of the Continent.

It will be remembered that after the war, plans were under consideration by the Transport and Communications Commission of the United Nations to improve the waterways of Western and Central Europe on an international basis. One scheme was to perfect the waterway connection between the Rhine and the Danube by completely canalising the River Main to Bamberg and by improving the existing canal from thence to Ratisbon. If this project was carried out, then Austria and the Balkan countries would have direct connection by water with the Western European ports, and with Emden via the Ruhront-Dortmund-Ems Canal, and thus another important step towards freer international trade would have been taken.

Although the uncertain international situation has undoubtedly retarded the early implementation of this scheme, nevertheless, by the construction of the Amsterdam-Rhine Canal, a link in the chain has been forged, and it is to be hoped that events will render possible, in the future, the inauguration of a fully co-ordinated system of international inland transport on the Continent, which would go far towards promoting a closer union of the countries of Europe.

The Volga-Don Canal.

Another waterway development of the greatest importance has also been completed in the U.S.S.R. According to reports from Moscow, a centuries-old Russian dream was fulfilled when Don River waters were released into a newly-built canal to join those of the Volga, thereby linking two of Russia's great rivers and forming part of an immense waterway from the Baltic to the Black Sea.

This is the first completed project of five post-war constructions termed "great edifices of Communism." It will be remembered that work on the building of the canal was begun before the Second World War, but was interrupted during the German invasion, and was resumed in 1947.

The navigable canal extends more than 60 miles across the Steppes from Stalingrad to Kalach, and will enable small sea-going vessels to operate between the Baltic, the White Sea, the Caspian Sea, the Sea of Azov and the Black Sea. It involved the construction of 13 sluices, three dams and a large number of pumping stations, bridges and wharves.

According to the overall plan, the Aral Sea will form part of this new system by 1957, when the world's longest canal, called the "Main Turkmen Canal," will bring Aral and Amudarya waters, 1,100 kilometres away, to the Caspian Sea.

The St. Lawrence Seaway.

Last month it was announced in the American press that the United States Senate, spurning a last minute plea by President Truman, had again rejected a Bill to authorize the United States to join with Canada in constructing the St. Lawrence Seaway and Power Project. Thus, the Senate has repeated the action it took in 1947 by adopting the motion to return the Bill to the Foreign Relations Committee for further study.

As already reported in previous issues of this Journal, the Canadian Parliament has announced that it will proceed with the

Editorial Comments—continued

project alone. Work can commence on the Seaway part of the scheme next year, but the associated hydro-electric undertaking needs the consent of the International Boundary Commission, which may take some time to secure.

It is estimated that eventually, more than £150,000,000 worth of electrical and heavy engineering equipment will be required, and apart from the hydro-electric schemes in association with the Seaway, the building of several new ports and the improvement of the Port of Montreal are involved.

Recent reports that discussions are now taking place between the Canadian High Commissioner and the Ministry of Supply and others, regarding British participation in the scheme are premature, and in this connection the Commonwealth Relations Office issued a statement a few days ago which says, " Reports appearing in the Press regarding United Kingdom interest in the project give an incorrect impression of the position. There have been no official talks with the Canadian High Commissioner. Naturally, there is a great interest in such an important long-term project and inquiries are taking place, and are expected to continue, on the extent and nature of possible participation by United Kingdom industrial concerns."

In view of the fact that British industries are already heavily committed in the re-armament programme, their inclusion in the scheme will pose some considerable problems, which it is hoped will, in due course, be satisfactorily resolved.

The possibilities opened up by the Seaway Project for the further development of both Canada and the U.S.A. are tremendous, and it is much to be regretted that the United States has again refused to be a partner in the scheme. Many of our readers will endorse Mr. Truman's pronouncement that the failure of the United States to participate is " one of the worst economic mistakes " it has ever made. Fortunately, however, the possibility of collaboration in the future still remains.

New York Pier Reconstruction.

Problems concerning the fendering of jetty structures have become of greater importance during recent years, owing to the increase in the size of vessels, and our readers will recall that this subject has been frequently referred to in past issues of this journal.

It is therefore interesting to note that to facilitate the docking at New York of the new American liner, " United States " (53,330 tons), the City of New York has spent $1,350,000 in rebuilding a pier, the main feature of which is a landing fender at its north-west corner that will enable the liner to enter or leave without waiting for slack water. Because of the heavy ebb tide in the Port of New York, big liners usually await slack water to avoid any damage. The fender incorporates a hollow rubber cushion which will bounce the liner off the pier if wind or tide swings her in as she is docking. Also, under some tidal conditions, the liner will be able to swing round against the fender to enter or leave the pier. It is predicted that use of the fender will save hours in turning round the ship in port.

Pollution of Sea Water by Oil.

There is no indication that the pollution of sea water by oil is abating; in fact, judging from the many reports of contamination around the shores of Great Britain, it appears to be increasing.

Apart from the harmful effect upon sea birds, fish and marine vegetation, there is evidence that sea-side resorts also are suffering serious damage due to oil pollution of the beaches. Indeed, this aspect of the problem was heatedly discussed last month at the Conference of the Association of Health and Pleasure Resorts, where many protests were made at the expense and inconvenience caused to coastal amenities.

Our issue of July last year, contained an article summarizing the position regarding past legislation, and reviewing the research work which is proceeding. It will be remembered that, at the instigation of the United Nations Transport & Communications Commission, it was agreed that an investigation into all aspects of the matter should be carried out by the British Ministry of Transport and comparable organisations of other countries, and this is still in progress.

British shipowners, in common with those of other maritime countries, have long been concerned with the seriousness of the problem, and although the draft convention proposed before the war has not been ratified internationally, their shipmasters have been given very definite instructions regarding the discharge of oil in coastal waters. Moreover, in view of the increase in pollution and of the emergence of fresh information as a result of scientific research, the Chamber of Shipping of the United Kingdom and the Liverpool Steam Ship Owners' Association, have set up a committee to deal with the wider aspects of the subject, and to collaborate with the Ministry of Transport.

There is no doubt that the matter has now assumed alarming proportions, especially in view of the greater amount of crude oil now being shipped to this country for refining. It is to be hoped, therefore, that collaboration between the Ministry of Transport and the two influential bodies mentioned above will result in some of the problems being resolved, and more especially that difficulties attaching oil separation or treatment of oil waste will be overcome. In the meantime, it seems that more stringent supervision of oil installations and of shipping in territorial waters is desirable. Also, we suggest that considerably heavier penalties should be imposed upon masters of vessels and others convicted of pollution offences.

Hydrographic Surveying.

The paper by Mr. Staveley, which will be found on a following page, on direct graphical methods of plotting by transit lines and arcs is a useful contribution to the economics of harbour reconnaissance. Echo sounding, developed commercially after World War 1, provided the Surveyor with means for obtaining abundant and immediate soundings at high speeds which precluded the use of the lead.

That the benefits of echo sounding should be so unnecessarily limited by inefficient station fixing techniques robs it of the economic and scientific advantages of concentrating on the fine weather conditions which admit of precise determination to within plus or or minus 3 inches of depth.

Traditional methods for plotting the position of the survey vessel from double simultaneous sextant angles by station pointer unfortunately did not at first permit the higher sounding speeds to be used to their best advantage.

Location by station pointer requires at least 40 second intervals between fixes for accurate work, and does not leave the Surveyor as free as he should be to correct courses and generally supervise the ship's track, in a tide-way for example.

From a scientific point of view it is essential that plotting techniques, established in harbour areas liable to continuous re-survey, should keep pace with the speeds of sounding now made available by the new development.

Methods for location of a surveying vessel within a sound trigonometrical framework by means of two intersecting lines *or* arcs of position, have now been successfully developed and, when exploited to the full, can give the Surveyor complete and deliberate control of the entire plot at a reasonable speed for rapid examinations of under-water areas.

A paper by Commander Macmillan, which appeared in the August 1938 issue of this Journal, shows that, whilst he had developed a fundamental sextant graph technique in this country, previous developments along these lines in the U.S.A. were applied by the War Department for the survey of the River Mississippi.

Mr. Staveley has shown ingenuity in adapting the principle in a great variety of forms for continuous re-survey of the Dublin Harbour area and approaches and his work will be read with profit by hydrographic surveyors with similar problems. The advantages attending the use of the double optical square should be widely appreciated, and it is noted that Mr. Staveley has made good use of the technique in all its aspects.

In the recent war, examinations of under-water areas were made at a speed of 15 knots, using the sextant graph method, and it is, of course, possible to double-up observers to obtain fixes by alternative parties at say 10-15 second intervals for close plotting at high speeds.

Those who have pioneered in this method are satisfied that the graph plotting technique has now become an essential feature in harbour conservancy.

The Amsterdam-Rhine Canal

The Port of Amsterdam's new link with the Hinterland

By Ir. C. van AMERONGEN, c.i.

Introduction.

TRADE intercourse between Amsterdam and the German cities of the Rhine dates back to mediæval times. For hundreds of years the existing natural waterways, with comparatively minor local modifications, could adequately deal with the waterborne traffic between these two traditional centres of commerce. More extensive improvements were subsequently made, but by the latter half of the 19th century the volume of trade and the size of the vessels navigating these ancient waterways had increased to such an extent that it became imperative to establish a new and more efficient connection between Amsterdam and the Rhine.

To meet these requirements the Merwede Canal was dug. This canal, which was opened in 1892, was designed for navigation by vessels up to 1,200 tons and provided a direct connection between Amsterdam and the northern arm of the Rhine, called the Lek, at Vreeswijk, while an existing canal linking the Lek with the Waal (the southern and larger arm of the Rhine) was widened and deepened. As a result of this improvement the importance of Amsterdam as a transit port between the ocean-going trade and the Rhine trade showed a steady increase, especially in the decade preceding the First World War. This upward trend was resumed in the period between the two wars and, after a temporary decline due to the 1939-45 war, has continued up to the present day. This is amply evidenced by the following figures representing the cargo capacity of the vessels using the Merwede Canal:

in 1893	3,500,000 tons
1913	12,000,000 tons
1925	19,000,000 tons
1939	21,000,000 tons
1951	23,800,000 tons

Most of this traffic was between Amsterdam and Germany or the southern part of Holland. The figure for 1951 represents a total of 82,500 vessels passing through the canal, the great majority of which made the voyage by way of the Waal. It is estimated that about 60 per cent. of all vessels that hitherto followed the route leading past Vreeswijk will henceforth go via Wijk-bij-Duurstede and Tiel.

The Merwede Canal, though in many respects a great improvement on previous facilities, soon proved to be inadequate to the needs of modern inland navigation. It was deficient in width, the capacity of its locks was too small, and the progress of vessels was further hampered by the presence of numerous low swing-bridges. In order to reach the Waal the vessels were, moreover, compelled to make a detour by way of Gorkum.

Plans were drawn up for improving the existing portion of the Merwede Canal between Amsterdam and Utrecht and for excavating an entirely new canal between Utrecht and the Lek at Wijk-bij-Duurstede and thence to the Waal at Tiel. The project, which included a branch canal to Vreeswijk, received the official sanction of Parliament in 1931; work on the new scheme was interrupted by the war and was resumed in 1946. The opening ceremony of the new canal was performed by Queen Juliana on May 21st, 1952.

Improvements and Advantages.

The Amsterdam-Rhine Canal has brought about a considerable saving in time on the voyage between Amsterdam and the German frontier. Not only has the actual distance by the Waal route been reduced by 40 kilometres, but vessels will be able to navigate the new canal at greater speeds, while much time is saved in passing the locks. On the old route between Amsterdam and the Waal no fewer than four locks had to be passed, each entailing a delay of about two hours; in the new canal there are normally only two locks (those south of the Lek crossing being kept open almost all the year round) and the delay caused by each of these is only 40 minutes. Thanks to these various improvements the duration of the voyage is reduced by at least 20 hours.

The Port of Amsterdam is adapting itself more and more to the requirements of transit trade and is well equipped with facilities for the transhipment of cargoes from sea-going vessels into canal and Rhine barges and vice-versa. Modern electric cranes unload steamers into barges lying alongside two-abreast. Adequate repair yards for barges and other craft are available. A bunker-ship and a floating tank station at the entrance of the new canal supply the barges with fuel.

Towns situated along the Amsterdam-Rhine Canal will benefit by the improved connections, which will stimulate the establishment of new industries and the expansion of existing ones. An inland port with access to the canal has already been constructed a short distance north of Tiel.

It is also intended in the future to use the canal for diverting part of the water of the Rhine to the sand dunes along the North Sea coast which form the chief source of water supply for the large towns of western Holland. By thus artificially raising the water-table of the dunes, larger supplies will become available for industrial and domestic use.

General Description of the New Canal.

The total length of the waterway, from Amsterdam to Tiel, is about 72 kilometres. The work of widening and deepening the existing canal between Amsterdam and Utrecht is still in progress, but when completed the new channel will have a width of 50 m. at the bottom as compared with only 20 m. for the original canal. At the same time the depth of water will be increased from 3.30 m. to 4.20 m. A further increase of the bottom width to 74 m. is envisaged in the more distant future. The old swingbridges across this length of canal are being replaced by high-level bridges giving 9 m. clearance above water level.

The entirely new stretch of canal from Utrecht to Wijk-bij-Duurstede has a width of 33.40 m. at the bottom, while in the portion between the latter town and Tiel (i.e. the canal connecting the Lek and the Waal) this width is 41 m. Provision has been made for the future widening of these portions of the canal to a bottom width of 74 and 52 m. respectively and also for duplicating the locks at Wijk-bij-Duurstede and Tiel for dealing with the ultimately anticipated volume of traffic.

The whole canal with its locks and bridges is basically designed for navigation by vessels of 2,000 tons, but the dimensions of these structures are such that they will permit the passage of larger craft, including even the largest Rhine barge afloat (4,300 tons).

The water level in the canal between Amsterdam and Wijk-bij-Duurstede is -0.40 m. in relation to Normal Amsterdam Datum (N.A.D.) throughout its entire length. This same level is maintained in all the canals in Amsterdam itself as well as in the North Sea canal connecting the city with the sea. The whole route from Ymuiden on the North Sea to Wijk-bij-Duurstede on the Lek is therefore free of locks. To achieve this it was necessary to construct long lengths of the new canal between dykes high above the level of the surrounding country, much of which lies a long way below sea level. Where the canal crosses existing waterways lying at a lower level it was, of course, necessary to build locks in the latter or, in some cases, to pass these waterways through culverts under the new canal.

The water level in the Lek at the point where it is crossed by the canal varies from $+1$ m. to $+8$ m. N.A.D. This necessitated the construction of a lock in the canal where it enters the river from the north-west. Although the portion of the canal between the Lek and the Waal is normally kept in open connection with the former river, the dykes along its banks are not designed for coping with the highest water levels in the Lek. A set of two locks situated side by side has therefore also been provided south-east of the Lek crossing. The gates of these locks will be closed only during the short annual period of highest water levels which is reckoned not to exceed about 15 days a year.

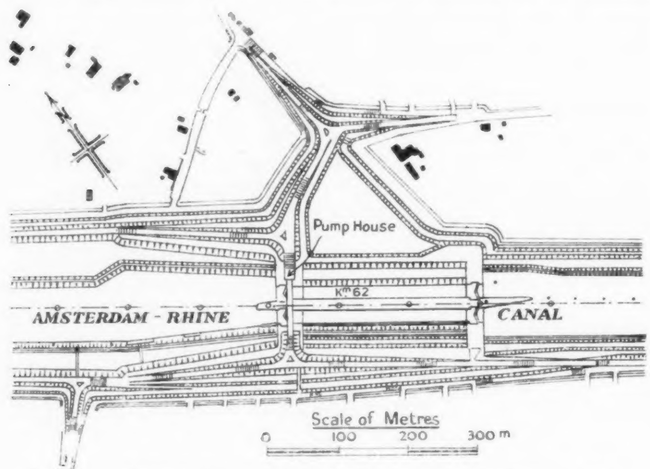
The Amsterdam-Rhine Canal—continued

As the water level in the Waal varies from +1.90 m. to +10.40 m. N.A.D., and is therefore at all times higher than that in the Lek, it was necessary also to construct a lock in the canal where it enters the Waal at Tiel.

The twin locks south-east of the Lek crossing each have an effective length of 260 m. and are equipped with mitre gates. The lock north-west of this crossing has a lock-chamber 350 m. in length and vertical-lift gates. It is divided into two sections by an intermediate gate and has a width of 18 m. The lock at Tiel has approximately the same overall dimensions, but is provided with two intermediate gates which divide the lock-chamber into three lengths of 90, 170 and 90 m. respectively. The Waal end of this lock is equipped with a vertical-lift gate, while the three other gates are of the mitre type. This lock, which is the largest inland navigation lock in the world, is connected with the River Waal by an approach channel with a length of 1,100 m.

The branch canal to the Lek at Vreeswijk is also provided with locks where it joins the river. These are constructed as twin locks with a chamber length of 225 m. and a width of 18 m. and are equipped with vertical-lift gates.

The time required for opening and closing the gates of all these locks is approximately 1—1½ minutes. Levelling up or running



Twin locks at Lek end of Lek-Waal section of the Amsterdam-Rhine Canal.

off the lock-chambers takes from 6 to 12 minutes and is effected by means of sluice openings in the gates. Tumbling chambers built into the gates destroy the energy of the inrushing water.

Waiting basins with reinforced concrete mooring dolphins connected by footbridges and floating catamaran-type timber fendering are provided at all the locks. The lock installations also include ladders, bollards, water-level gauges, sirens, loudspeakers, signalling lights, illumination, etc.

About ten years have gone into the construction of the canal, while the work of improving the old Merwede Canal between Amsterdam and Utrecht is expected to take another two years. The total cost of the new canal and its ancillary works amounts to 90 million guilders (nearly nine million pounds sterling), of which 40 million had already been invested before the war. If the entire project had been constructed at post-war cost, the total amount would have been in the region of 170 million guilders. The Tiel lock was completed at a cost of 14 million guilders. The Lek-Waal section of the canal involved the moving of about six million cubic metres of earth, representing about one-third of the quantity for the whole canal. This latter section of the canal, including the crossing of the Lek, is the most interesting from an engineering point of view and will be described in greater detail below.

The Canal Connecting the Lek and the Waal.

This last portion of the Amsterdam-Rhine Canal crosses the river Lek at Wijk-bij-Duurstede and joins the Waal near Tiel. The water level in the Lek varies from +1.00 m. to +8.00 m. N.A.D., while that in the Waal varies from +1.90 m. to +10.40 N.A.D. The level in the latter river is at all times higher than that in the Lek, the greatest difference being about 2.50 m.

During the greater part of the year this portion of the canal is kept in open connection with the Lek and therefore has the same level of water as this arm of the Rhine. The lock gates at the north-western or Lek end are closed only during the comparatively short period (averaging about two weeks a year) when the water in the Lek rises above +5.55 m. N.A.D. During this time the level in the canal is artificially maintained at +5.55 m. N.A.D. For this purpose a pumping station is provided which discharges into the Lek all additional water entering the canal in consequence of rainfall and the passage of vessels through the locks at each end.

On the other hand, the lock at Tiel, at the south-eastern end of the canal, is in operation all the year round, as the water level in the canal is always lower than that in the Waal.

The Lek Crossing.

A very interesting feature of the new canal is the solution adopted for crossing the Lek. The crossing had to be effected in such a way that the conditions of flow in the river would not be unduly interfered with, while at the same time vessels could safely cross the river even at times of high water levels without experiencing too much difficulty with the current. In addition, arrangements had to be made to prevent the approach channels to the locks in the canal on either side of the river from silting up and thereby to obviate extensive maintenance dredging.

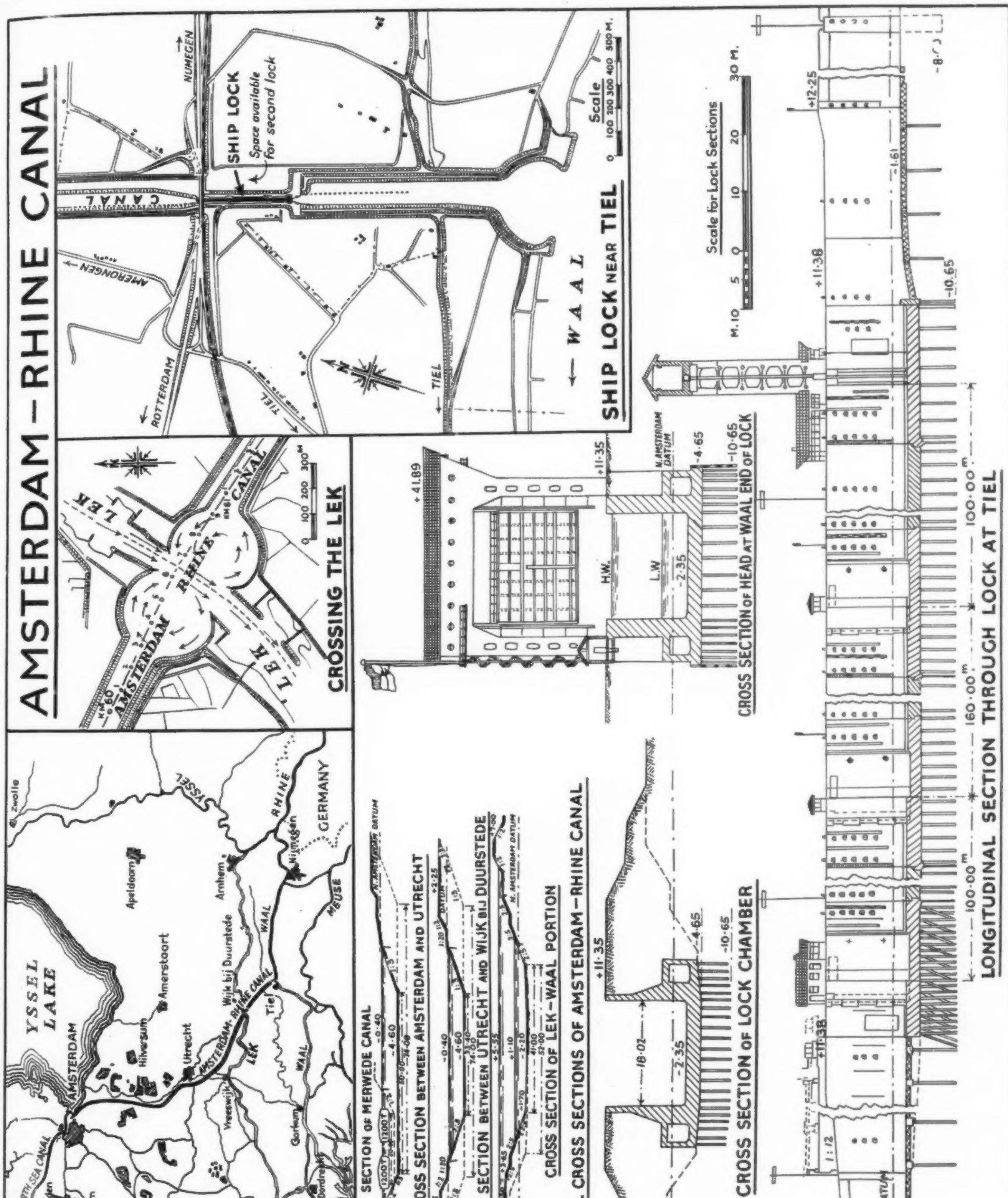
Before the present solution was finally adopted, elaborate observations of the discharge of the river and of the quantities of sand transported by the current were made over a long period. Besides, extensive experiments were carried out in the Hydraulics Laboratory at Delft with a view to determining the correct shape and dimensions of the canal entrances.

The observations showed that the Lek at Wijk-bij-Duurstede annually transports about a quarter of a million cubic metres of sand. By far the greater proportion of this material is transported at water levels between +2.50 m. and +5.50 m. N.A.D. At this point of crossing, the river has a width of 136 m. between the heads of the groynes which form the boundaries of the summer flow channel. The bottom level of the river was approximately −0.50 m. N.A.D., while the level of the bottom of the canal on either side of the crossing was −1.70 m. N.A.D., i.e. more than 1 m. below that of the river itself.

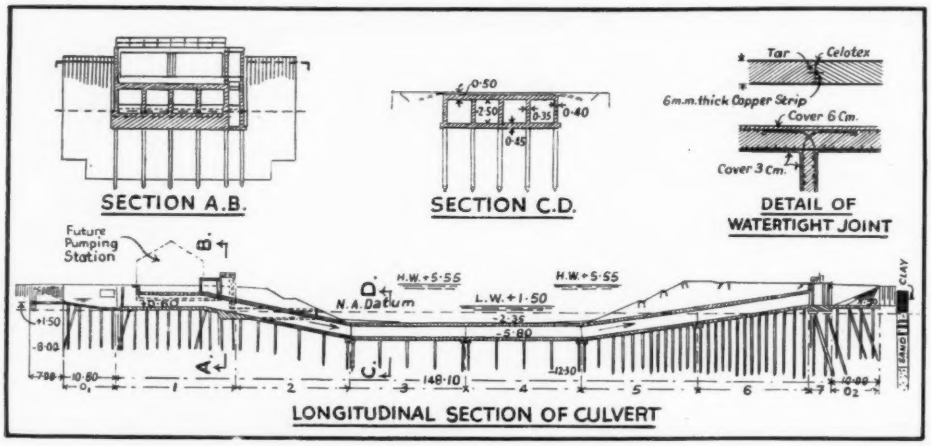
As the width of the canal entrances is 295 m., some of the groynes had to be demolished. Their task of guiding the current was taken over, as it were, by the circular currents set up (chiefly by friction) in the widened entrance basins by the main current in the river. These circular currents act as "rollers" for guiding the main current, which is thus carried past the canal entrances. In this way the least possible flow of river water into the canal is secured, thereby reducing to a minimum the sanding or silting up of the approach channels to the locks. This is further achieved by the construction of short piers on either side of the entrance. The purpose of these projecting piers is to give additional guidance to the circular currents; the two upstream ones, moreover, reduce the width of the summer channel of the river to 85 m. and have the effect of deflecting the main mass of transported sand into mid-stream. These piers are of composite construction, consisting of steel sheet-piling capped with concrete. Each pierhead is provided with a beacon light for marking the canal entrance at night and at high water levels when the rest of the piers is submerged.

At the point where the canal crosses the Lek a transverse excavation had to be dredged in the river bottom in order to bring it down to the level of the canal bottom. Upstream of the canal entrances the summer channel of the river has been artificially reduced in width so as to increase the velocity of the current. It is hoped thereby to maintain the excavation at its correct depth, sand deposited during periods of low water being swept away when the level rises.

The path of a vessel crossing the river is an S-shaped curve, the vessel moving in a direction opposite to that of the circular current in each entrance basin. The flow channel of the river is crossed at an angle of 45 degrees in relation to the direction of the main current.


AMSTERDAM – RHINE CANAL
NORTH SEA
YSSEL LAKE
AMSTERDAM
Ymuiden
NORTH SEA CANAL
Haarlem
The Hague
ROTTERDAM
Dordrecht
Gorkum
Vreeswijk
Hilversum
Amersfoort
Utrecht
Apeldoorn
Zwolle
YSSEL
Arnhem
Nijmegen
GERMANY
RHINE
WAAL
MEUSE
LEK
Tiel
Wijk bij Duurstede
AMSTERDAM–RHINE CANAL
CROSSING THE LEK
LEK
AMSTERDAM
RHINE
CANAL
0 100 200 300M
SHIP LOCK NEAR TIEL
SHIP LOCK
Space available for second lock
NIJMEGEN
AMERONGEN
ROTTERDAM
TIEL
WAAL
CANAL
Scale
0 100 200 300 400 500 M.
TYPICAL CROSS SECTIONS OF AMSTERDAM–RHINE CANAL
CROSS SECTION OF MERWEDE CANAL
CROSS SECTION BETWEEN AMSTERDAM AND UTRECHT
CROSS SECTION BETWEEN UTRECHT AND WIJK BIJ DUURSTEDE
CROSS SECTION OF LEK–WAAL PORTION
N. AMSTERDAM DATUM
CROSS SECTION OF LOCK CHAMBER
+11·35
18·02
-2·35
-4·65
-10·65
CROSS SECTION OF HEAD AT WAAL END OF LOCK
+41·89
+11·35
H.W.
L.W.
-2·35
-4·65
-10·65
Scale for Lock Sections
M.10 5 0 10 20 30 M.
LONGITUDINAL SECTION THROUGH LOCK AT TIEL
100·00 m
160·00 m
100·00 m
+12·25
+11·38
-1·61
-10·65
-8·(?)
1:12
+11·38

The Amsterdam-Rhine Canal—continued



Sections through Linge culvert.

The twin locks at the north-western end of the Lek-Waal canal, which were completed in 1940, are built about 1,100 m. back from the river. The approach channel has a width of 75 m. at the bottom. These locks are separated by a central pier. The outer walls of the lock-chambers are not vertical but are in the form of banks sloping down into the water and provided with reinforced concrete dolphins with timber floating fenders. The lock-chambers are 260 m. long and 18 m. wide. The mitre gates are closed only when the water in the Lek rises above +5.55 m. N.A.D. Levelling up and running off the lock-chambers is effected by means of sluice openings in the gates.

The pumping station for maintaining the water level in the canal during this short period when the lock gates are kept closed is situated underneath the high-level road bridge at the western end of the locks. It is equipped with two horizontal 240 h.p. diesel-driven rotary pumps each having a capacity of approximately 5 cu.m./sec. at a lift of 2.50 m. The water is drawn from the canal through two reinforced concrete culverts of 2.90 m. x 3.50 m. rectangular section running the whole length of the locks.

The Canal Banks and Their Protection.

The canal between the Lek and the Waal has a width of 41 m. at the bottom, with an envisaged future widening to 52 m. At a water level of +2.00 m. N.A.D. the cross-sectional area of the canal is approximately 200 square metres, i.e. about six times the cross-sectional area of a 2,000-ton barge. The angles of the slopes of the banks were determined on the basis of calculations and tests for ascertaining the shear resistance of the soil.

Dykes with a crest level of +6.50 m. N.A.D. were constructed along the canal for retaining water levels between +4.50 m. and the maximum permissible level of +5.55 m. N.A.D. The dykes were sown with grass, and as these high water levels occur only for a comparatively short period, no further precautions for protecting the dykes were deemed necessary.

Below the +4.50 m. level the slopes are provided with an asphalt protective casing which is continued down to 1 m. below low water to give the banks adequate protection against the destructive action of the suction caused by vessels passing at high speeds. This protective casing was constructed in the dry. A row of short piles or stakes provides support at the toe of the casing, which consists of a 10-15 cm. thick layer of packed natural stone bedded in 4 cm. of coarse sand. The cavities between the stones were filled with sand-bitumen (a mixture consisting of 37% coarse sand, 37% sand, 14% asphalt, 12% filler, heated to 200° C. and spread while hot). The average thickness of the sand-bitumen layer is 12 cm.; about 90 kilogrammes of asphalt per square metre of casing were used. In this way a form of bank protection was obtained which was strong enough to withstand physical damage and yet was flexible enough to adapt itself to any slight deformations of the cross-section caused by settlement.

In places where the banks of the canal were of very soft material a different form of protection was applied. This consisted of large reinforced bitumen-sand mats, 8 m. x 9.50 m. in size, composed of 74% sand, 16% bitumen and 10% filler. The reinforcement was in the form of a 30-cm. mesh made of stretched sisal rope. The mats were placed in position with the aid of a floating crane.

In so far as the spoil was to be used for the construction of approach embankments to bridges, for dykes and for other earthworks, excavation was done by draglines. The rest of the excavation was carried out by bucket and suction dredging. The redundant spoil was disposed of in various ways. It was used as backfill for harbour works near Tiel, deposited in disused claypits along the Lek, or dumped at a central disposal site on the east side of the canal.

At about two-thirds of the distance from the Lek to the Waal the canal crosses a small river, the Linge, which is carried through a culvert of reinforced concrete construction. This culvert has four channels of square cross section with a total area of 25 square metres.

The Tiel Lock.

The lock at Tiel, at the south-eastern end of the canal, is built 1,100 m. back from the river. The maximum difference in water level between the canal and the open river is 4.75 m. Various roads and a railway are intersected by the canal in the neighbourhood of this lock. The piers and abutments of this bridge, which will really consist of a series of five independent parallel bridges, are wide enough to take two single-track railway bridges, two highway bridges with a 7.25 m. width of road surface, and one highway bridge with a road surface 6 m. in width. At present only one railway bridge and one road bridge have been constructed. All these bridges are of the continuous girder type with seven spans of 26.80 m. each and giving 8 m. clearance above the highest water level in the canal. The construction of the approaches and other embankments involved the shifting of over a million cubic metres of earth.

The main dykes of the river are extended northward along the approach channel as far as the entrance heads of the lock. They also extend southward on to the foreshore of the river (which is submerged at high water levels) as far as the low-water channel in order to afford protection for this portion of the approach channel, against cross currents when the river is in flood. In order not to constrict the high-water cross-section of the Waal too much, a length of river dyke on the opposite bank was moved further south, while the level of the foreshore on this side was lowered by excavation. The approach channel to the lock has a widened circular entrance basin similar to those at the Lek crossing.

The lock-chamber at Tiel has a length of 350 m. and is trough-shaped in section. Owing to the poor quality of the subsoil the whole lock is built on a foundation of 35 cm. x 35 cm. square precast reinforced concrete piles 6 m. in length. Two intermediate gates divide the lock-chamber into three sections having lengths of 90, 170 and 90 m. respectively. This arrangement provides a choice of four different lengths of chamber, viz. 90, 170, 260 and 350 m. The length of chamber to be employed will, of course, be determined by the requirements of the traffic passing through the lock at any given time. It may be noted in passing that the length of 260 m. represents the standard longitudinal dimension of the lock-chambers in all the main canals in the southern part of the country.

The centre-line of the lock is displaced 26.80 m. to the west of the centre-line of the canal itself, provision having been made for the future construction of a second lock of the same size beside the one already in existence. The canal will then be excavated to its full width of 52 m.; allowance for this future development has already been made in the spans of the bridges. The present lock is in line with the centre of the third span of the bridge (reckoned from the west bank of the canal); the second lock will be on the centre-line of the fifth span. The projected widening of the canal will be achieved by dredging on the east side only.

The Amsterdam-Rhine Canal—continued

The river end of the lock is equipped with a vertical-lift gate weighing approximately 190 tons, the other gates being of the ordinary mitre type (each leaf of which weighs 65 tons). The vertical-lift gate is similar to those installed at both ends of the lock at Wijk-bij-Duurstede north-west of the Lek crossing. A gate capable of being installed in either of these locks is kept in reserve in a depot near the Lek end of the canal.

The water level in the lock-chamber is controlled by means of six sluices equipped with flat sliding paddles in each gate. The paddles are fitted with bronze strips which slide over pressure-lubricated stainless steel strips attached to the gate. The sluice openings in the gates are designed as tumbling chambers for destroying the energy of the inrushing water and contain timber cross beams for this purpose. In addition, special timber grids and current deflectors for securing uniform distribution of the inflowing water over the whole cross section of the lock-chamber are fitted to the inner sides of the gates. The design for this part of the equipment of the lock was based on the results of extensive experiments in the hydraulics laboratory.

For effecting repairs to the gates or to the lock itself or as an emergency measure, the lock can be closed at each end by means of upright dam boards. These " boards " are broad-flange steel joists with timber filling. They are supported at their lower ends by a groove of triangular section in the floor. Their upper support is provided by a steel box girder spanning transversely across the lock and floated into position when required.

The mitre gates work in heavy granite quoins firmly anchored into the concrete. The blocks are also anchored to one another with dowels. The pointing sills are provided with cast-steel rabbets. Fixed to the gates are strips of timber covered with rubber which, when the gate is closed, is in watertight contact with the cast steel. The thrust exercised by the leaves of the gate is transmitted to the concrete walls through stainless steel cushions.

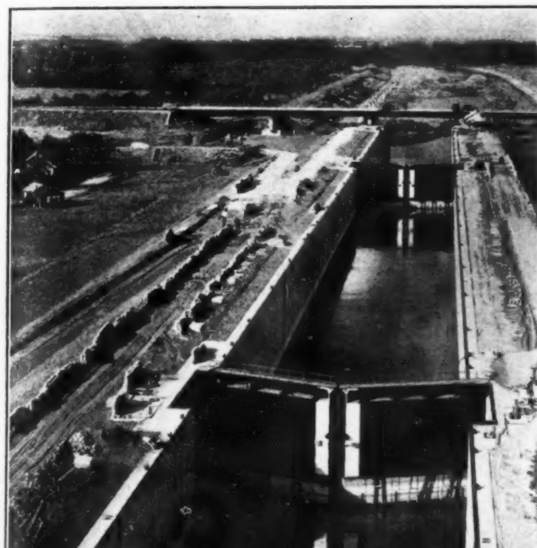
The vertical-lift gate has timber strips which bear against steel jambs. Each of the two grooves in which the gate moves is provided with three runners; above the level of the top of the lock-chamber walls vertical steel runners for the raised gate are supported from the inner sides of the vertical towers forming the uprights of the gate portal.

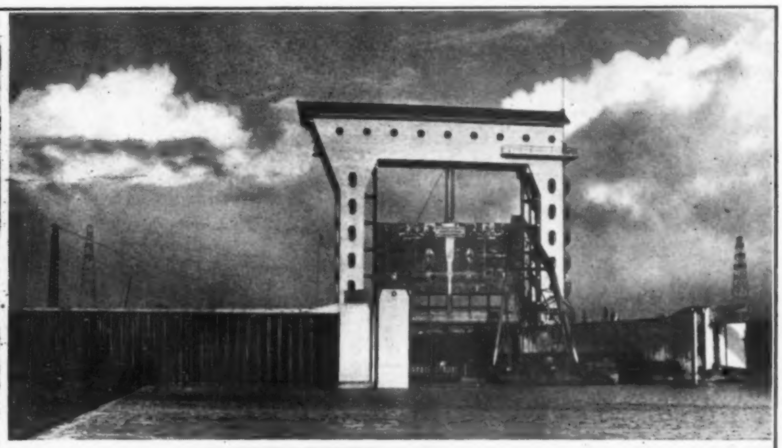
Construction of the Lock.

The lock was constructed in reinforced concrete with transverse joints at intervals of 15.50 m. The joints in the floor slab, which has a thickness of 2.30 metres, are rabbeted and are rendered watertight by the insertion of water-stops. The vertical joints in the walls are of the tongue-and-groove type and are likewise provided with water-stops. To prevent water from working its way around and under the lock, a number of steel sheet-pile walls are provided under the floor and behind the lateral walls. These sheet-piles have the same depth of penetration as the bearing piles. In addition, walls composed of short timber sheet-piles have been placed at every other transverse joint. The purpose of these is to limit the size of any cavities which may be formed under the floor slab in consequence of compaction or settlement of the subsoil.

Each lateral wall contains a culvert with a cross section of 3.20 m. x 3.65 m. These culverts enable water to be diverted from the Waal to the Lek independently of the lock itself. They are each 455 m. long and the flow of water through them is regulated by means of sluice gates of special construction.

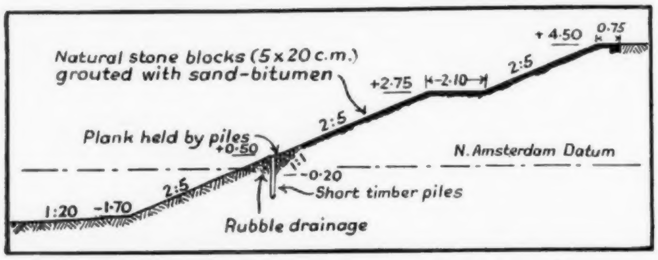
The lifting mechanism of the vertical-lift gate is installed in the cross beam surmounting the two lateral towers. These towers have a relatively low stiffness so as to allow a certain measure of elastic deformation due to temperature expansion of the cross





(Above) The lock at Tiel with only two intermediate gates placed, seen from the tower structure of the outer gate. (Top right) Entrance to the lock from the waiting basin in the River Waal. The vertically opening gate has been partly lifted. (Bottom right) A lengthwise view of the lock. The intermediate gates, when opened, disappear into the walls.

The Amsterdam-Rhine Canal—continued



Asphalt revetment of Lek-Waal section of canal.

beam or to minor displacements or settlement of the walls of the lock.

The approach channels at both ends of the lock are equipped with reinforced concrete mooring dolphins spaced at 22 m. intervals in a row approximately 500 m. in length. The dolphins, which are of 2.50 m. x 2.50 m. squar section and were constructed in the dry, are connected at the top by foot-bridges having an H-shaped cross-section and built in pre-stressed concrete according to Freyssinet's method. It was thus possible to keep the weight of these structures low, while their total cost was actually somewhat less than that of similar footbridges in conventional reinforced concrete.

Construction work on the lock was commenced in 1939 and temporarily stopped in 1942. It was resumed in 1946 and completed early in 1952. The excavation for the foundations was kept dry by means of well-point dewatering employing pumps of the submerged type. Three pile-frames each drove an average of 15 piles a day, 6,466 piles being driven in all. These piles, which had a length of 6 m., were all cast on the site. Internal vibrators were used in their manufacture.

The floor and walls of the lock were poured in four lifts with horizontal construction joints at the following levels: -2.00 m., $+0.70$ m. and $+1.70$ m. N.A.D. The concrete for the first three lifts was placed with the aid of a travelling gantry spanning the lock and was supplied by two travelling mixers each with a capacity of 1 cubic metre. The gantry carried two narrow-gauge railway tracks for conveying the concrete from the mixers. Placing was done by means of tremies and chutes. With this method an hourly rate of placing of between 45 and 50 cubic metres was attained.

The concrete for the final lift of the west wall was placed with skips carried by an aerial ropeway; that for the east wall was poured with chutes fed by concrete wagons raised by a hoisting device. The ropeway cable spanned the lock transversely between travelling towers on each side. This ropeway was also used for lifting reinforcement bars, piles, formwork, etc.

For supporting and aligning the steel in each lift, some of the

Bridges across the new canal, south of Utrecht.

bars were welded to special frames constructed of angle-iron and incorporated in the walls together with the reinforcement. These supporting structures were of especial importance for the construction of the final wall lifts which were nearly 10 m. in height, six being provided per 15.50 m. bay.

Travelling formwork was used for constructing the inner faces of the lock chamber walls, the same method having previously been employed with success in the construction of the locks at Wijk-bij-Duurstede and Vreeswijk. The shuttering for the outer faces of the walls consisted of four separate sections per bay, which were moved to fresh concreting positions by the aerial ropeway. Screwed mild steel tie-rods of 18 mm. diameter with re-usable end connections were employed. The soffit shuttering for the cross beam of the gate portal was supported by two braced girders with a span of 23.20 m. and carried a load of 500 tons.

The two intermediate gates were installed before water was admitted to the lock. The approach channel between the lock and the river dyke (which at the time was still intact) was then filled with water to a specially selected high level by means of a temporary pump installation. This was done for the purpose of testing the stability and impermeability of the new dykes built on either side of the approach channel. This water level was kept constant for a period of three days and then lowered at a rate of 20 cm. a day. In the course of this test observations were carried out by the Delft Soil Mechanics laboratory. On completion of these investigations the approach channel was dredged to its final depth and the connection with the Waal established by digging away a portion of the river dyke. The vertical-lift gate and the leaves of the mitre gate at the opposite end of the lock were thereupon floated into position by means of pontoons and installed with the aid of a floating crane.

The operation of raising or lowering the vertical-lift gates takes only one minute. In its raised position the gate provides 8 m. clearance above the highest occurring water level.

Vertical-Lift Lock Gates.

It may not be inappropriate, by way of conclusion, to devote a few words to the subject of vertical-lift gates. Gates of this type have of recent years been employed in a fairly large number of navigation locks (with widths varying from 12 to 18 m.) in the Netherlands. They present certain advantages :

(1) The length and therefore the cost of the entrance and exit "heads" of the lock is reduced.

(2) In contrast with mitre gates the vertical-lift gate can function bilaterally, i.e. it can retain high water levels in two directions.

(3) All the vulnerable parts of the gate are readily accessible for inspection and the execution of repairs.

(4) If suitable tumbling bays are provided, levelling up the lock-chamber can be effected simply by raising the gate. (The vertical-lift gates in the Amsterdam-Rhine Canal locks are, however, equipped with sluice openings for this purpose.)

(5) The gate itself is simple in construction and in operation.

The disadvantages are that the tall tower or portal structures tend to make this solution a costly one; the power consumption for opening such gates is higher than that for gates of the ordinary type; and the available headroom is, of course, restricted.

Vertical-lift gates are usually constructed of a single skin of steel plate backed by transverse girders (which in large gates may be of the braced type and parabolic or trapezoidal in shape) spanning between lateral vertical members fitted with wheels or rollers. The weight of the gate is almost wholly compensated by counterweights moving up and down in the side towers.

Although in some modern Dutch navigation locks levelling up or running off the chamber is accomplished by raising the gate, at first slowly till the water levels on either side are nearly equal and then more rapidly, this solution was not adopted for the locks in the Amsterdam-Rhine Canal. Because of the great difference in the levels of the water on either side of the gates at certain times of the year, the wheels or rollers would have been subjected to very high pressures and would have had to be of elaborate and costly construction. For this reason sluice openings have been provided in the gates, which can be rapidly raised when the water levels have become almost equal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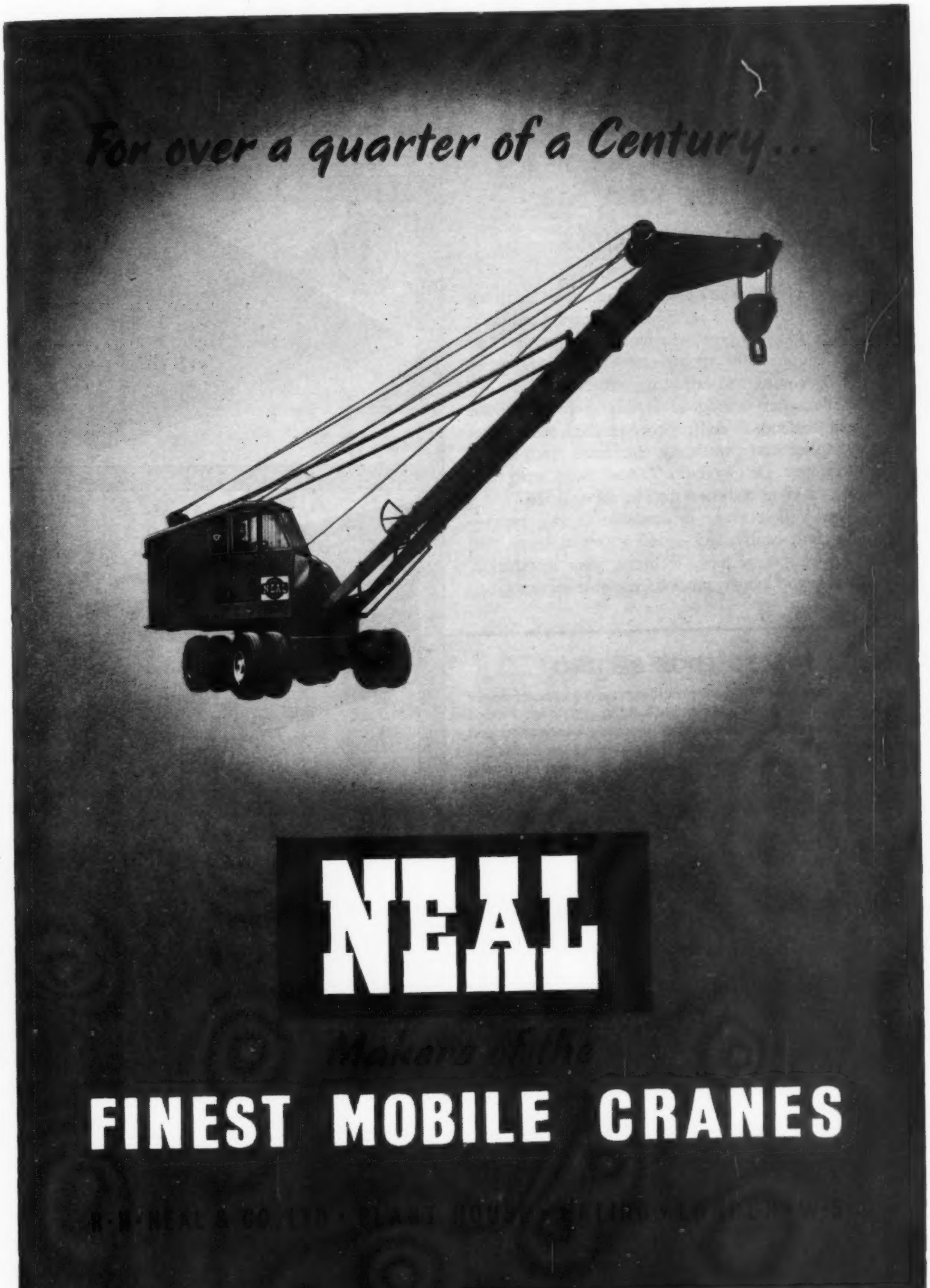
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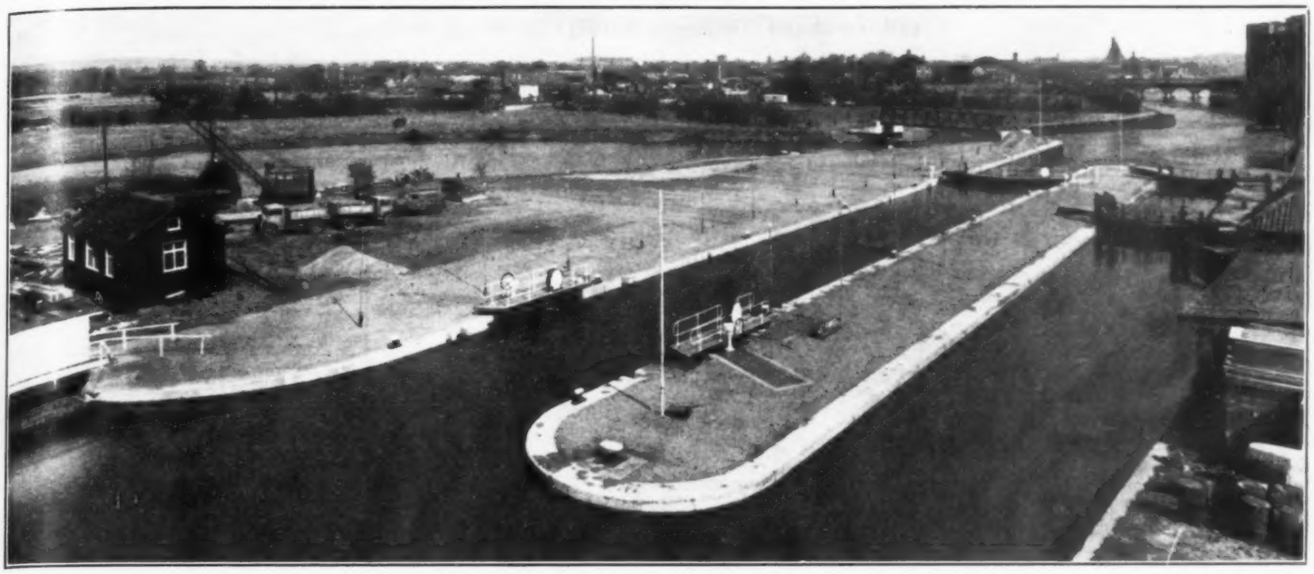


April 1952. Downstream view of complete lock from inner end showing old lock to right. A new workshop has since been erected on the vacant ground in the middle of the picture.

New Lock at Newark-upon-Trent

Improved Navigation to Colwick

(Specially Contributed)

Introduction.

A MODERN lock at Newark, built by the Docks and Inland Waterways Executive to facilitate the movement of traffic on the Trent Navigation between the Humber and Nottingham area, was officially opened on April 18th last. It is the first major structural improvement carried out since the war on any inland waterway in the United Kingdom.

The new lock will be able to pass in one operation a unit of four standard Trent craft carrying about 500 tons, or a large single craft of 200 to 250 tons capacity, according to the type of cargo. The old lock could deal only with single craft of the standard Trent type, but the new lock will enable the larger craft, including an increasing number of oil tankers, to extend operations up to Colwick. Later, when certain other work has been done they will be able to reach Nottingham.

At the present time the River Trent splits into two channels at Averham Weir above Newark, the northern channel flowing past Averham and Kelham, whilst the southern channel flows through Newark to join the former channel at Crankley Point approximately two miles below the town.

Under the Trent Navigation Act of 1906, powers were obtained to construct six new locks on the River Trent as part of a scheme for improving the navigation from Nottingham to Gainsborough. These improvement works were carried out, but there still remained a "bottleneck" at Newark Town Lock and at Holme immediately below Nottingham, where certain works will shortly be undertaken by the Trent River Board as part of the Nottingham Flood Protection Scheme.

Powers were later obtained under an Act of 1932 for the construction of a new lock at Newark and land was purchased for the river diversion.

Preliminary investigations were undertaken in 1949 and construction was commenced in 1950. In addition to the New Lock, the works included the construction of a steel sheet pile mole to form a guide wall to the lock entrance, the diversion of a short section of the river in order to eliminate a sharp bend and to improve conditions of flow, and the construction of a new bridge to afford access over the river and maintain a public right-of-way.

Site Investigation.

In order to obtain accurate information of sub-soil and ground water conditions for the final design, site investigation by means of borings, soil sampling and soil testing was carried out.

Four borings were put down to depths of 36-ft., 30-ft., 40-ft. and 30-ft. respectively, and in all borings the main formation of Red Marl was found under a layer of gravel, which was overlain by typical river silt in three borings and by a sandy clay in boring No. 4. The top layer was formed in all borings by made-up ground, which in Nos. 1—3 consisted of indifferent material of varying nature; clay and bricks, clay and stones, bricks, clay and sand, whilst in No. 4 it comprised a dirty gravel. The ground water level in all borings corresponded approximately to the water levels in the neighbouring canal, basin or river, or rose to these levels as soon as water was struck in the river silt or gravel.

The made ground varied from place to place and could only be considered as a surcharge, and tests were, therefore, carried out on this material.

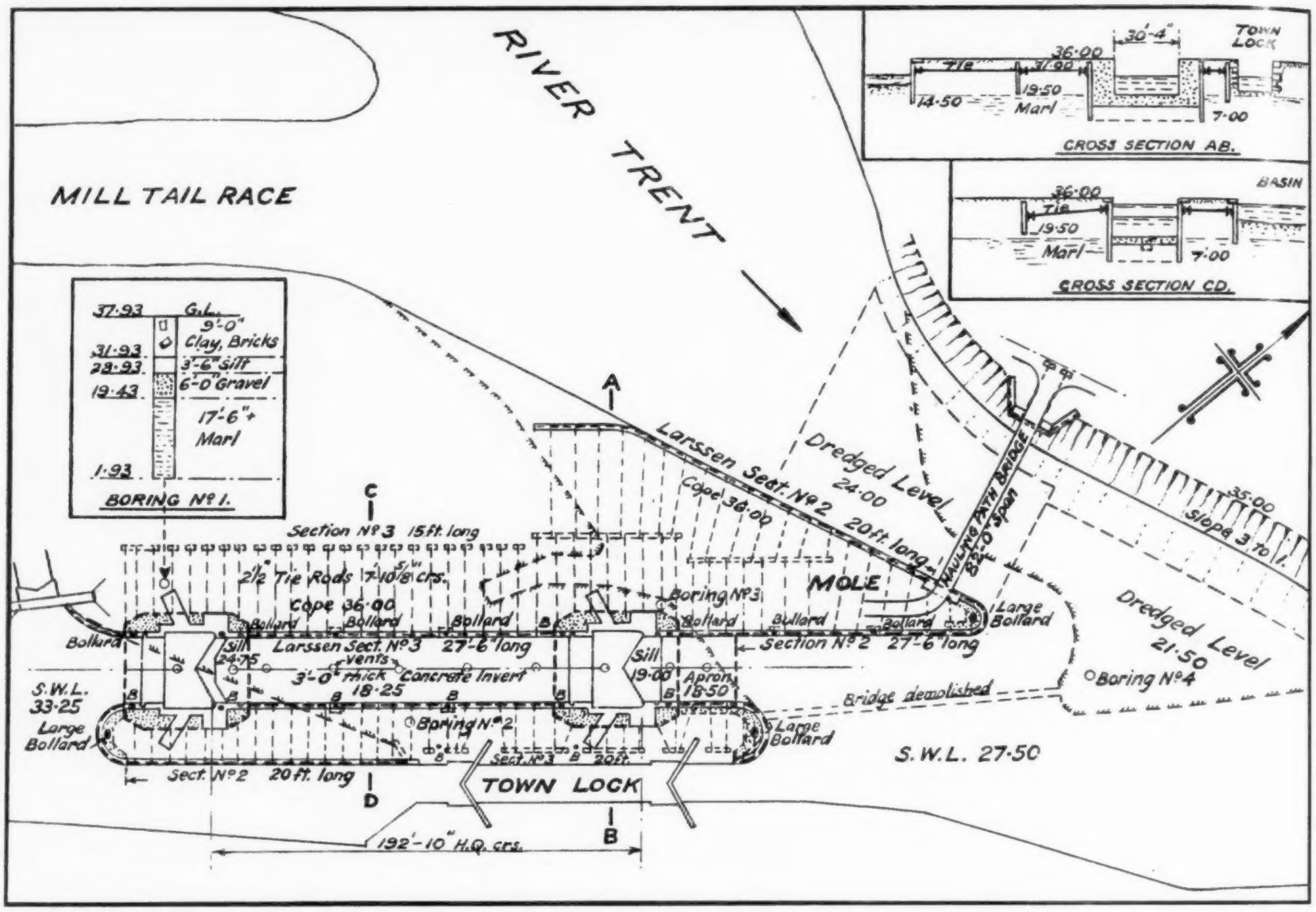
The river silt varied in thickness from 2-ft. to 6-ft. 6-in. and was regarded as an original deposit of relatively recent age, being very wet and soft, composed of a clayey silt with large peaty enclosures and a considerable amount of organic matter. Its bearing capacity was considered negligible.

The gravel layer had a thickness of 6-ft. to 10-ft. and was a sandy gravel well graded and of high bearing capacity suitable for sheet pile anchorages.

The red marl, the surface of which varied from +16.67 O.D. in boring No. 4 to +19.43 in boring No. 1, was not a uniform stratum, being composed of alternating layers of plastic clay and of shale. At certain places it appeared to be slightly granular and in one sample the chalk content was determined as approximately 20 per cent. of the total dry material. Accordingly, though it appeared rather cohesive, it was not regarded as impermeable, particularly not in thin layers.

The shaley nature of some layers made it impossible to obtain really undisturbed cores, and the shear strength of the marl was assessed on recompacted samples with larger stoney portions of the shale removed.

New Lock at Newark-upon-Trent—continued



Plan of Newark Lock with two cross-sections inset.

It was considered that the marl was not a suitable material to form the lock bottom because a slow plastic deformation would lead to gradual disintegration.

General.

The new lock was sited to the north of and parallel to the existing Town Lock. Its upper limit is the entrance to a dry-dock and in consequence the lower end of the lock projects into the River Trent. At this point the river made a sharp left-hand bend of some 130° and in order to obtain improved conditions of flow, some river diversion was essential. This allowed the northern wall of the lock to be carried forward in the form of a mole to provide a "lead in" for vessels navigating upstream and sheltered mooring for vessels waiting to enter the lock.

A new hauling path bridge was necessary to maintain a public right of way, and the most suitable position was considered to be from the end of the mole spanning the diverted river channel.

Dimensions.

The principal dimensions of the new lock which conform with those of the main locks on the River Trent are :

Length, Hollow Quoin—Hollow Quoin ...	192-ft. 10-in.
Width between fenders	30-ft. 2-in.
Width at gates between concrete walls ...	30-ft. 4-in.
Depth over inner and outer sills at S.W.L.	8-ft. 6-in.
Rise at O.S.W.L.	6-ft. 3-in.

Consideration Affecting Design.

The preliminary design in steel sheet piling formed the basis of the final design and, in consideration of the possibilty of flooding from the river, and to restrict flooding in the event of a "blow" in the bottom, the gate chambers were constructed in cofferdams. To avoid a complicated design of steel sheet piled cofferdam at the gate chambers, usually necessary when constructing small reinforced concrete pillars for the reception of the gates, the gate recesses were constructed in mass concrete and the walls extended to incorporate stop grooves and sills above and below each gate.

In order to maintain a method of emptying and filling the lock similar to that at the other Trent locks, it was decided to fit sluices to each gate leaf and not construct wall culverts, although the mass concrete gate chamber walls could readily have contained culverts in the wall around each gate.

Design.

The steel piled walls to the lock body and to the gate cofferdams were designed as propped cantilever walls with one line of walings tied back to steel sheet pile anchor panels. The "Deflection Line Method" used in the design requires the following conditions to be fulfilled :

(1) The sum of moments about the tie rod connection to be zero.
(2) The summation of loads on one side of the wall to equal the summation of loads on the other side.
(3) There should be no deflection at the tie rod connection.
(4) A vertical line passing through the tie rod connection to be tangential to the deflection curve at the toe of the wall.

The soil characteristics such as weight, angle of internal friction and cohesion, were based on laboratory tests and the effect of ground water was taken into consideration.

The mass concrete invert was designed on the virtual arch principle and vents were considered a necessity, particularly whenever the lock was to be dewatered for repairs, so that relief could be provided for upward water pressure.

The concrete gate chamber wall was designed on the assumption that a 15-ft. length of wall above the Hollow Quoin acts as a

New Lock at Newark-upon-Trent—continued

monolith with the length of wall below the hollow quoin; the latter length not exceeding 15-ft. in the calculation. Below the gate it was assumed that the lock was dewatered for repairs.

The stability of the wall was checked in two directions; normal and parallel to the centre line of the lock, and the effect of the earth pressure and the support offered by the steel sheet piling were neglected.

METHOD OF CONSTRUCTION

Steel Sheet Piling : The cofferdams of the Gate Chambers, the Lock Body and Pierheads are constructed in Larssen steel sheet piles, Section No. 3, 27-ft. 6-in. long; the Mole and the old lock side of the Inner Pier are constructed in Section No. 2 piles, 27-ft. 6-in. and 20-ft. long. The piling is connected to anchor panels formed in Section No. 3 piles, 15-ft. long, by means of 2½-in. diameter M.S. tie rods, generally spaced at 7-ft. 10⅝-in. centres. The walings are formed of two R.S. Channels, 9-in. x 3½-in.

Excavation : Excavation in dumpling and invert to the Lock Chamber was carried out after the piles had been driven and, because of the probability of the water-bearing strata exerting severe pressure on the piling before the invert had been concreted, the ground water level was lowered by installing a system of well-points. Fifty-one well-points were jetted down and connection to a 6-in. diameter ring main from which air was evacuated and the water discharged by means of a well-point unit (duplicated in case of failure), comprising an air vacuum pump and centrifugal pump directly coupled to a Diesel engine. Despite the short distance from the river and the old lock, the lowering of the water table was a decided success and there was no evidence of the abstraction of fines.

Invert : The six to one concrete invert was laid in consecutive strips 15-feet wide on a sound marl formation providing adequate bearing. The invert to the Lock Chamber is 3-ft. thick, ten vents being formed in the invert to relieve any upward water pressure. An interesting item in the construction of the vents was the use of 2-ft. diameter porous concrete pipes, which extend below the concrete invert into the marl. A 3-in. x ½-in. M.S. Angle was welded to the face piles as a connection between the piling and the concrete to give the necessary shearing resistance in the event of upward water pressure.

Lock Gates : Heel, mitre posts and certain beams subjected to heavy loading are of greenheart, other beams are of oak, whilst the gate fenders are of wych elm. Each loat has sluices each 3-ft. x 2-ft. operated by one sluice box on the footboard.

September 1951. Lock body and head gate chamber looking west. Three 15-ft. lengths of invert placed. Head gate chamber partly completed. Boxing-out for forebay plates. Cross dam burnt off and removed. Bagged wall to inner pierhead and dam as protection against possible flooding.

Each gate is opened and closed by a racking arm in gear with a manually-operated standard. Dutch elm sills at an angle of 25 degrees are fixed to the concrete by means of lewis bolts and wedges for easy renewal.

Hollow Quoins : Cast iron Hollow Quoins, cast as part of a circular pipe with flanges mated by dowels and bolted together in unit lengths, are held in position by bolts screwed into cement-in sockets for easy replacement, if necessary.

Stops : When repairs are necessary, horizontal timber stop logs, housed in the stop grooves formed in the side walls, will be supported by vertical steel joists housed in pockets in the invert end attached at the top to a horizontal girder placed in recesses near the coping level.

Fenders : Vertical fenders of Douglas fir faced with oak rubbing pieces are fitted into the steel piles and the pierheads are backed in mass concrete.

Hauling Path Bridge : The bridge, which has a clear span of 82-ft., is of conventional design in light lattice girder steelwork with a R.C. decking. Two box piles provide the necessary support at each abutment.

Concrete Copings : Precast concrete copings in 4 to 1 mix, 3-ft. wide and 18-in. deep, are set on top of the piles. These copings are dowelled and jointed in 2 to 1 cement mortar.

The estimated cost of the works, which took 17 months to complete, was £64,114. The contractors were Messrs. Chas. Brand & Son, Ltd., Charles II Street, London. The lock gates were constructed and fitted by the North Eastern Divisional Staff of the Docks and Inland Waterways Executive.

The whole of the works were designed and executed under the supervision of Mr. G. R. Fenton, O.B.E., M.I.C.E., M.I.Struct.E., Divisional Engineer, North Eastern Division, Docks and Inland Waterways Executive.

Obituary

MR. G. L. LYON, M.C., M.B.E., M.Inst.T.

We regret to record the death on the 11th June last of Mr. George Limnell Lyon at the early age of 41. He was the Vice-Chairman of Messrs. Lyon and Lyon, Ltd., and Joint Managing Director of each of its subsidiary companies; these include Messrs. John Harker, Ltd., shipbuilders, repairers and inland waterway carriers of Knottingley, Yorks.

During his 20 years' association with John Harker, Ltd., and the associated firms, the shipbuilding and inland waterway carrying industries in Knottingley have undergone great expansion, in which his energy and enthusiasm have played a large part. The new "Dales" class fleet of fuel-carrying motor tankers, with their modern living accommodation has been built for the firm's inland water transport service. With the shipyard manager (Mr. E. K. Thirkettle) who retired last year, Mr. Lyon was concerned in the design and development of these boats, which are known not only on the Yorkshire canal systems, but on the Humber, the Mersey and the Severn. Another development has been the bunkering service to trawlers in the Humber, for which the John Harker boats are specially equipped.

He was educated at Uppingham and Cambridge University and was a Member of the Institute of Transport. He served in the Army during the 1939-45 war and attained the rank of Lieut.-Col. in the Transport Division of the Royal Engineers. He was present at the evacuation of Dunkirk, played a large part in barging operations in the Nile Basin and the Eastern Mediterranean, and later served in Sicily and Italy. He was awarded the Military Cross and mentioned in Despatches.

Mr. Lyon will be remembered for his contributions to this Journal on the operation of inland water transport, upon which he has always advocated a progressive policy, based on sound economics. His early death will be a great loss to this industry.

Harbour Radar

Advantages of Equipment Designed for Shore Use

(Specially Contributed)

THE advantages to be obtained from the employment of shore-based radar for observing the movement of shipping in ports are becoming increasingly appreciated. In good visibility radar can provide an additional service; in bad visibility it can be the means by which all the other services can be kept running when otherwise they might have been brought to a standstill.

During the past two or three years, a number of articles describing the working of port radar have appeared in "The Dock and Harbour Authority," and last month, this Journal published a Report on the working of a marine radar at the Port of Sunderland, which had been installed by arrangement with the Ministry of Transport. The equipment used was an ordinary shipborne radar which had been adapted for shore use, and from the experiments which were carried out during a 12-month trial period, much valuable information was obtained concerning the value of radar for assisting port working, irrespective of the size of the port.

It should be realised that the different sizes of harbour and the different types of approach call for different equipments. For example, a large port, such as Liverpool, which is situated on a river with a winding approach, was fitted with special equipment, which, being designed for this specific purpose, was correspondingly costly. On the other hand, a smaller harbour situated on the coast and having an easy approach would obviously need a smaller and less complicated apparatus

Hitherto, the tendency has been for each harbour to be treated on its merits, so that individual sets have been designed to meet the requirements of a particular port and this, of course, has involved additional production costs. Several manufacturers of radar have, therefore, been experimenting with the production of standard sets which could be produced at a reasonable price.

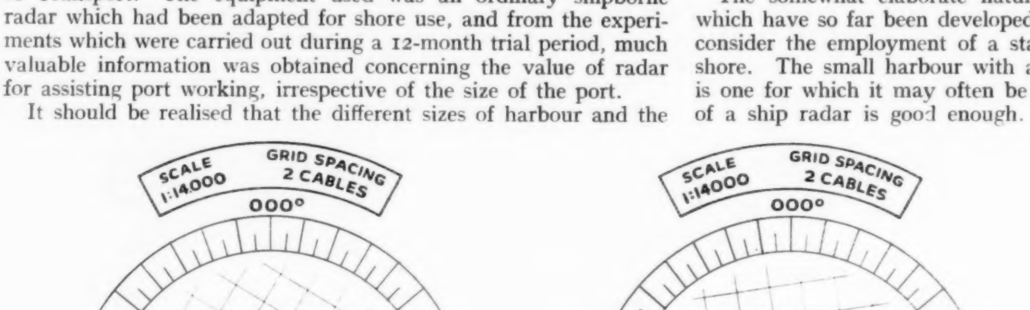
Towards the end of 1950, Messrs. Decca Radar, Ltd., announced the introduction of a large type harbour radar, which would be suitable for the larger ports. This equipment was installed at Hythe, on Southampton Water, about 18 months ago, and a full description appeared in the February, 1951, issue of this Journal.

Introduction of a Simplified Harbour Radar.

The Company realises that sets similar to that at Hythe are likely to be considered too expensive for the smaller type of port, and in order to make harbour radar an economic proposition for these, a new equipment has now been produced, namely Decca Harbour Radar Type 30. This is a smaller version of the successful design adopted for the larger set, and although it incorporates a number of features especially designed to suit the needs of a harbour, it is only a little more costly than a normal marine radar.

To enable operational experience of the new equipment to be gained the Dover Harbour Board have kindly granted facilities for the new equipment to be installed experimentally in a building at the seaward end of the Prince of Wales Pier, which commands a good view of the inside of the harbour and its approaches. It has been arranged that tests will be extended over a period of several months to obtain the fullest experience of the new equipment.

The somewhat elaborate nature of the large Harbour Radars which have so far been developed have led a number of people to consider the employment of a standard Marine Radar for use on shore. The small harbour with a comparatively simple approach is one for which it may often be considered that the performance of a ship radar is good enough. Certainly such a radar can be of the greatest use to harbours of this type as is shown by the very successful outcome of the Sunderland trials described in the report mentioned above.



"Course made good 122°" "Buoy bears 081° from you, distant 2 cables"

Fig. 1. Illustrating the use of the new cursor for the rapid determination of courses, bearings and distances. One set of parallel lines allows the bearings to be measured, the other allows distances to be estimated, the spacing being shown by an illuminated panel which changes automatically when the range scale is switched.

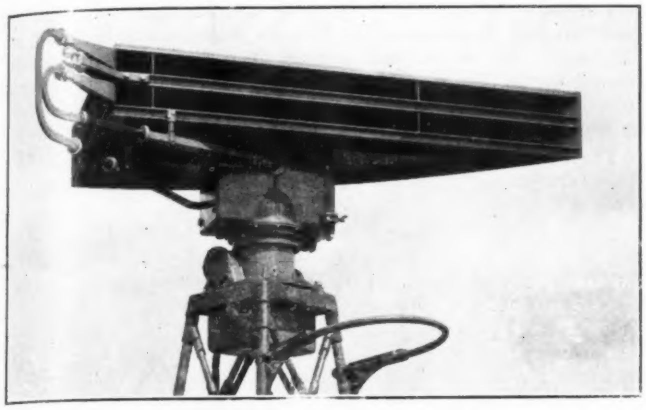
The ordinary Marine Radar has, however, been designed entirely with shipborne requirements in view, and before using it on shore it is worth while considering how well it fits the particular requirements which arise from the different use which is going to be made of it. The Decca Company have carried out a very thorough survey of the requirements of the smaller harbour in order to determine whether an equipment of similar performance and price to that of a Marine Radar could be developed specially for the harbour in order that it can do the job required of it with the greatest suitability and convenience.

It may be of general interest to review briefly the points in which the Company consider that there are special requirements differing from those normally met with in a shipborne radar and which justify the development of special equipment.

Essential Requirements.

The use of the equipment in a built-up region where there are very strong echoes from the numerous buildings, docks and the like places a particular importance on the need for ensuring that the aerial produces the minimum possible side-lobes. If this is not done, the picture in such a region will be so cluttered with false

Harbour Radar—continued



An illustration of the 6-ft. Scanner.

signals from side-lobes that the equipment will be unusable unless the gain is reduced to such a low value that the danger of failing to detect small craft becmes very real. For this reason the development of a special aerial of higher performance than that normally envisaged for a shipborne radar becomes highly desirable.

The geographical configuration of the port is often such that if the site of the radar station appears in the centre of the P.P.I. as it will do with the normal shipborne equipment, then probably at least half of the displayed area will be wasted on land echoes of no interest to the user. It is far preferable to displace the centre of rotation towards the edge of the display so that the area of interest is displayed to the best advantage and permits the use of the largest scale.

When off-centering is employed in the display the normal bearing cursor cannot be used for the measurement of bearings and it is thus worth while examining the question of what type of bearing information is required from a Shore Radar. These requirements seem to fall into two different categories; in the case of fixing the position of a navigational mark the requirement is for the maximum accuracy, and speed of operation is of no importance; when passing information to an incoming ship speed of operation is all important.

The former requirements for fixing the position of a navigational mark can readily be met by arranging for the display to show a set of electronic range and bearing marks so than an accurate "spider's web" is automatically drawn on the display. The range and bearing of the mark can then be read off from this with precision and can be plotted on the chart to give an accurate fix. Such a system will find a number of applications wherever accurate fixing is necessary and time is available to obtain the reading and to plot on the chart.

In the case of passing information to a ship which is under pilotage, to give her the range and bearing from the Radar Station would be of little value since she cannot use this information until she has plotted it and time will usually not be available for this operation. In normal conditions the master or pilot is accustomed to observing his position by noting where he is relative to a nearby buoy or other known navigational mark. It is thus preferable that the radar should be able to give information in this form. This can be done by using a rotatable cursor with a set of grid lines drawn on it so that the relative bearing of any two desired objects can be read off rapidly; by knowing the distance represented by the spacing between the cross lines an estimate of distance can also be given. With a little practice such a system can readily give bearings with an accuracy of about two degrees and distances which can be estimated to within at least 10 per cent.; when a vessel is given her position by reference to a nearby mark to this order of accuracy the error in her position is very small indeed. Fig. 1 shows the type of cursor which could be used for this job and illustrates its method of employment for determining courses made good as well as for giving positional information.

It will be desirable, in many cases, to have a large-scale view of part of the harbour as well as a general view of the approaches. While this can be done by switching the scale of the display it will usually be preferred to have two displays so that one is permanently giving the largest scale view and the other maintaining a long-range look-out. The equipment should therefore be designed so that either one display may be used where the maximum economy is required or that additional displays can be used where it is desired to improve the operational convenience.

In certain cases the best site for the radar may be a considerable distance from the position where it is desired to have the information centre and it should therefore be possible to add a Relay Link to the equipment so that the display may be repeated at a site several miles distant.

Description of the equipment at Dover.

During a recent visit to the Port of Dover, the writer was given the opportunity of inspecting the new equipment installed by Decca Radar, Ltd., and of observing the movement of shipping in the Channel. The apparatus has been constructed in a compact and economical form, with an aerial specially designed to give a good discrimination and freedom from sidelobes, and a display giving accurate fixes and instantaneous readings of courses and bearings.

The equipment consists of the four following units:

The Scanner Unit is of unusual design and makes use of two "half-cheese" aerials, one for transmitting and one for receiving. Each half-cheese has a width of 6-ft. and produces a narrow beam of 1.25°. The special feature of the aerial is, however, its very sidelobes, which have been kept down to the remarkably low value of 1.3 per cent. of the main beam (−29db.).

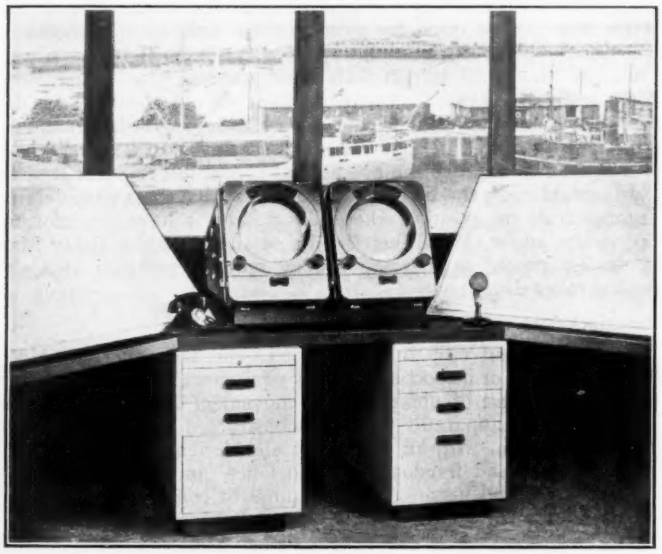
A further feature of the design is the use of the separate transmitting and receiving aerials which dispenses with the gas switches normally used with a common aerial, and thus brings about a worth while simplification of the transmitter and receiver unit which is mounted immediately below the scanner in order to avoid long waveguide runs and troublesome rotating joints.

The Display Unit embodies a number of new features designed to ensure the right presentation of the information and the maximum convenience of use. A 12-in. diameter cathode ray tube is used which gives a bright well-focused picture and shows all the echoes with great clarity.

A special rotatable cursor of the type referred to above is provided to allow bearings (or courses) and distances to be rapidly determined: both these operations can be accomplished with speed and accuracy. A special edge-illuminated perspex disc is also provided close in front of the P.P.I. on which can be marked a simple outline chart indicating navigation marks and so forth in order that the echoes from these can be rapidly identified and distinguished from those of nearby anchored shipping or small craft. An

Typical installation employing a single display.

Harbour Radar—continued



Typical installation employing two displays.

electronic " spider's web " of range and bearing marks can be switched on when required.

Although in many cases satisfactory results can be obtained with a single display, two displays will usually provide considerably greater operational convenience, and up to four can be used where special requirements make it desirable.

The Receiver Unit is mounted in a convenient, out-of-the-way position, and is connected by flexible cables to the Scanner and Display. The whole unit is built on a single chassis to which instant access is provided on removal of the front cover; it is light in weight and takes up a minimum of space, a feature which helps to simplify installation.

The Power Unit consists of a robust motor generator with carbon pile voltage regulator ensuring satisfactory operation within plus or minus 10 per cent. of nominal voltage.

Relay Link. Although not in use at Dover, the makers state that the relay link equipment developed for their larger installation on Southampton Water can be added to this new equipment when required in order to give a picture at a remote location up to 20 miles distant.

During the demonstration at Dover, an impressive feature of the installation was the clarity of the picture and the long range of the set. When the display unit was set at maximum range, the outline of the coast of France could be clearly seen at a distance of 20 miles, and many ships which were invisible to the naked eye, immediately came into view on the P.P.I., so that at the time of viewing, the movement of no less than 25 vessels in the Channel within a range of about 15 miles, could be followed without difficulty. With the display set to its largest scale (approximately 1 : 14,000), the picture of the harbour filled the screen, and piers, jetties and both entrances, were shown prominently, and buoys and a number of small yachts could be readily picked out. Also the cross-Channel boats could be observed alongside the jetty, and in particular, the " Invicta " was clearly seen to move as soon as her bow left the jetty. A tug could also be seen alongside the pier, and the after-glow " tails " of several ships were clearly distinguishable showing the directions of their courses.

The Institution of Civil Engineers

Models Exhibited at Conversazione

At a conversazione held at the Institution of Civil Engineers on the 19th June last, exhibits of scientific apparatus and models were on view, a number of them being of special interest to dock and harbour engineers.

The Port of London Authority exhibited a model, on a scale of 1/2500 of the River Thames between Westminster and Woolwich and at Tilbury, upon which all Docks, River Quays and nearby buildings were shown in relief. In addition, and to mark the 150th anniversary of the opening of the first of the modern enclosed docks, a small exhibition of prints illustrated some of the more important stages in the development of the Port.

Another exhibit consisted of a wave generator of novel design which was shown in conjunction with a recently developed wave measurer and recorder. Both are suitable for use in models of harbours and coastal regions in which the effect of wave action is to be studied.

The wave generator is designed to develop a train of mixed waves, composed of two fundamental frequencies, either of which may be varied over a wide range. Wave disturbances are frequently found in many harbours when waves of a certain length and period occur in the surrounding sea. The use of models is particularly valuable in studying the cause and removal of these disturbances. There is an obvious danger in finding a remedy when waves of only one period are developed in the model, since the cure may merely result in waves of a different period causing a similar disturbance. By use of the wave generator, a wide range of wave periods may be produced during any given experiment, so that any scheme may be tested under all likely wave conditions.

A further phenomenon which is frequently overlooked is the effect of a train of mixed waves on a structure. Designs are often based on the action of locally-generated storm waves, or of swell, each being considered separately. The worst conditions, however, are frequently found when local storm waves are superimposed on swell from more distant storms. It is difficult to predict the effect of such a disturbance, and the use of the new wave-generator will enable such conditions to be studied in models.

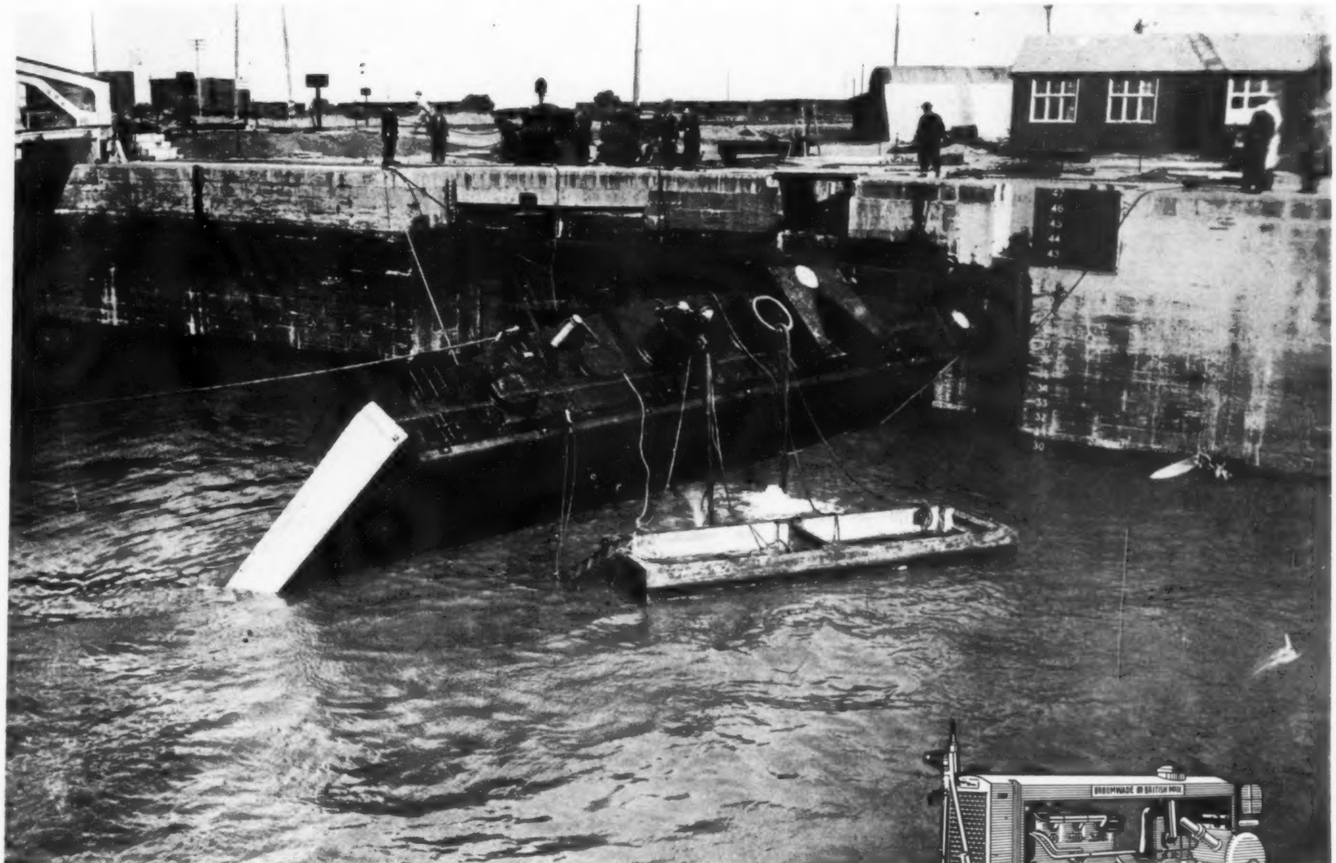
The electronic apparatus for measuring small water waves, which was shown in operation in conjunction with the wave generator described above, was designed by the Institute of Oceanography. Sir Bruce White, Wolfe Barry & Partners had been investigating the design of an instrument for use in measuring and recording waves in harbour models, and as a result of an exchange of information, the wave recorder developed by the Institute of Oceanography was found to fulfil harbour model requirements exactly. This instrument can measure very small waves on inland lakes and reservoirs for specialised research. It consists of a valve oscillator, of which part of the tuned circuit is a vertical wire through the water surface. Rise and fall of the water surface causes variation of the frequency of oscillation, which is detected by the recorder and made visible either by means of an oscilloscope, or on recording paper.

The Institute of Oceanography is devoted to the study of the sea in all its aspects. In this connection their research team has developed apparatus for the measurement of waves, currents and beach profiles, and their accumulated experience is available to any members of the civil engineering profession.

A model of a new type of sluice gate for irrigation and other purposes was also shown. The gate is designed as a shell in tension, and may be manufactured from plates of steel, aluminium, or other suitable materials, into the form of a segment of a cylinder. The water load on the gate is transmitted to grooves in the piers or abutments by trains of rollers, or in the case of small gates, by wheels. The ends of the gate pass through narrow openings in the grooves facing downstream, and are fitted with end vertical beams which bear upon the rollers.

The model has recently been under test at the Hawksley Hydraulic Laboratory of the Imperial College for observation of its hydraulic behaviour, and to investigate the possibility of self-induced vibrations. During these tests, which were carried out under all possible combinations of head and gate opening, the gate proved to be fully stable, and did not exhibit any tendency to vibrate.

Achievement . . .



Photograph by courtesy of Messrs. Vickers-Armstrong Ltd., and the Chief Docks Manager of Cardiff Docks.

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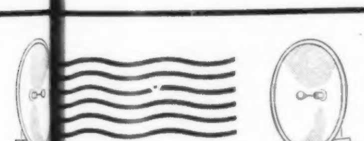
R.M.S. Queen Mary being joined by two tugs in Southampton Water. From an actual photograph of the PPI in the Type 31 Radar installed at Hythe.

TYPE 31



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DR 208

Hydrographic Sounding and Surveying

A Description of the Methods used in the Port of Dublin*

By WILLIAM F. STAVELEY, A.M.Inst.C.E. (Ireland).
Hydrographic Surveyor, Dublin Port and Docks Board.

Introduction.

HYDROGRAPHIC Survey is now a matter of considerable importance in most major ports. Over the last half-century, the increase in the size of ships, with their increased loaded draft, has necessitated the provision of deeper approach channels and berthages, calling for dredging operations at depths greatly exceeding those previously considered adequate. The economical use of dredging plant, in these days of rising costs, requires a precise dredging programme, which in turn depends on complete, accurate and up-to-date charts of all estuaries, approaches, fairways and docks in the area of a port conservancy.

The need for frequent and accurate hydrographic surveys, brought about by present-day requirements, calls for survey methods of speed and precision. The small margin of safety between draft and depth demands a superior order of accuracy in charting the greater depths of to-day than the lesser depths of some years ago. These conditions have stimulated the development of the echo sounder to provide a scientific instrument of a high degree of perfection. With a machine specially designed for hydrographic work installed in a suitably designed survey launch, the surveyor is equipped with a combination that will give results well up to the standard of accuracy required—provided, of course, that the attendant operational factors are taken carefully into account.

The old method of sounding under oars with a lead-line is gone and while due credit must be given to the excellent work done by surveyors of the past, this method can no longer meet the modern demands for speed and accuracy. That the surveyors of the past were well acquainted with the errors of the lead-line is manifest, as they adopted various precautions against over estimation of depth. The anxiety to be on the safe side, while understandable from a navigational point of view, could easily restrict the acceptance of large vessels or perhaps result in unnecessarily deep dredging. The hydrographic surveyor of to-day can measure depths to a high degree of accuracy and show them thus on his charts. Safety clearances are matters for those concerned with the navigation of a port.

The provision of deeper channels and deepwater berthage in the Port of Dublin has kept pace with the increase in trans-ocean tonnage. The annual total now clearing the port is well over double that of 20 years ago. Being one of the first ports in Europe to use the echo sounder for hydrographic surveying, the charting of the Harbour of Dublin has been almost completely carried out by this method since 1934.

Consequently, a fair amount of experience in sounding methods has been gained and certain ways of carrying out routine operations have been evolved, all designed to reduce work and make the most use of the survey time. These are described in this paper and while they are of necessity, fitted specifically to the Port of Dublin, it is felt that they may be of general interest and of some use in ports where recurrent surveys are regularly under way.

The Dublin Port and Docks Board Survey Launch.

The survey launch *Depthfinder* is a timber craft, built in 1949 (Fig. 1) to replace a small steel auxiliary steam tug, previously (though not exclusively) used for survey work. The new launch is substantially built, with liberal scantlings, to withstand the sudden vagaries of Dublin Bay weather. The layout in general follows the recommendations of Commander D. H. MacMillan, R.N.R. Hydrographer to the Southampton Harbour Board, laid down in his book *Precision Echo Sounding and Surveying*. The launch has the following dimensions: length 42-ft., breadth 10-ft. 6-in., draft 4-ft. It carries a 1½-ton lead keel. Three main compartments comprise the accommodation; the forecastle, the cabin amidships and the engine room aft. There are twin power units, two Morris " Commodore " 6-cylinder petrol engines of 20/40 h.p. each. These give a full speed of nine knots and a minimum speed, using one engine only, sufficiently slow for detailed survey work. The engines are placed well aft, resulting in full after-body lines. This is a good feature in a survey launch, as it reduces squat under way to a minimum. It also gives a good-sized engine room, which in this particular case houses two 40-gallon fuel tanks, an enclosed toilet, a Stuart-Turner battery charging set and a handy bench.

The main feature of the launch is the cabin amidships. It is the control centre to which the survey operations are directed, co-ordinated and recorded. The length of this compartment is 10½-ft., breadth 7½-ft., and there is ample headroom. It is almost completely glass panelled, giving the maximum possible all-round vision, permitting simple fix observations to be made from inside, in cold or rainy weather. The echo sounding machine is installed at the after end of the cabin and the transmitting and receiving oscillators, which are of the inboard type, are housed in small tanks fitted on the inside of the bottom of the vessel, underneath the cabin floor. The timber hull in the location of each oscillator tank is cut and fitted with a metal plate moulded flush with the outside of the vessel's bottom. The longitudinal position of the oscillators is slightly forward of the centre of flotation, where their level below the water line is unaffected by moderate changes of the vessel's trim. The survey observation point is directly above the oscillators; the doors to the cabin and the sliding hatches in the roof being fitted in this position and are used as observation posts.

The engine controls and the steering wheel are installed in the cabin, ensuring liaison between surveyor and helmsman during sounding operations. Instrument dials relating to engine performance are fitted on twin panels in front of the steering wheel. Launch speed can be graded and uniformly maintained by reference to engine r.p.m. indicators. The forward/reverse gear controls are hydraulic and interconnected with throttle control. The system used is the " Hyland " Twin Telegraph, fitted at the steering position. The whole arrangement gives complete control of the launch to the helmsman without the need for another man in the engine room. Sufficient launch speed when sounding is provided by the use of one engine only. Steering under this condition is practically unaffected; only a slight amount of contra-helm being necessary as the propellers are placed fairly close to the centre line of the vessel and forward of the rudder.

The windscreen in front of the helmsman is fitted with a " Kent Clear-View Disc." In addition to the normal deck equipment, a Loud Hailer is fitted on the cabin roof. This has various uses; mainly for instructing a tide-watcher ashore or directing a shore-party operating with portable sounding marks.

The Echo Sounding Machine.

The Echo Sounding Machine installed in the *Depthfinder* is the special " M.S. 10 " hydrographic model with magneto-striction oscillators, made by Kelvin and Hughes (Marine) Limited, London. This machine is now well known and fully described in the maker's publications. The recording of the soundings is effected by the electrolytic action of a small current passing from a rotating stylus through moist chemically impregnated paper. The record is permanent and the curved scale of the soundings is of the order of ⅛-in. to 1-ft. The instrument has a basic range of 0.40-ft., which can be increased by " phasing," a system by which the open scale is retained but the range increased by advancing the zero (the transmission impulse) in steps of 30-ft. Soundings are therefore possible from about 1-ft. below the keel of the launch down to a maximum depth of 490-ft. The radius of the stylus

*A Paper read before the Institution of Civil Engineers of Ireland on the 3rd December, 1951. Reproduced by kind permission.

Hydrographic Sounding and Surveying—continued

path is 9.38-in. and the basic scale of the record is contained in an arc of 30°. The curvature of the stylus path over the 40-ft. of the scale is, therefore, comparatively slight and this feature permits a straight scale equivalent, not cramped at its extremities, to be used for reducing and plotting the soundings from the record.

Calibration of the Echo Record.

Certain factors must be taken into account before an echo sounding can be expected to be a true depth measurement. (1) The velocity of sound through water varies with the temperature and the density. Consequently the speed of the recording stylus must be related to the speed of sound through water, at the time and in the location of the survey. (2) The transmission impulse takes place below the water line and its correct position with relation to the zero of the sounding scale must be ascertained.

The method of dealing with these factors is the simple and practical operation known as the " Bar Check Calibration," now generally used in day-to-day calibration of survey machines. It

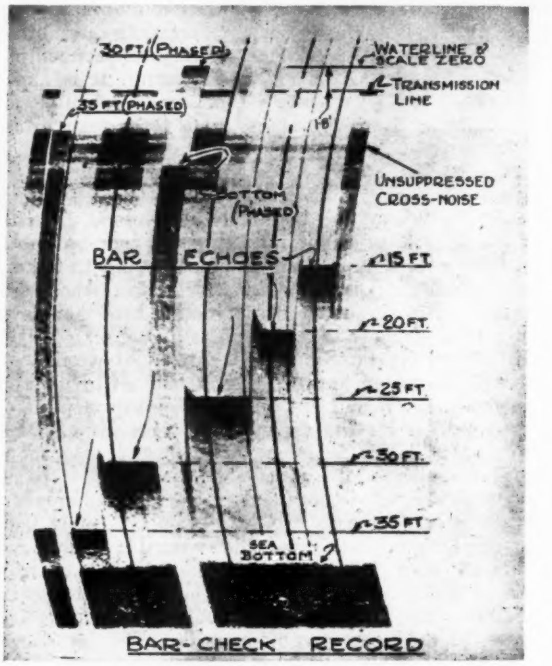


Plate 1. Typical Bar-Check Record.

depends on the ability of the echo-sounder to record an echo from a narrow " bar " suspended from the launch in a position directly beneath the oscillators.

As this operation is described in detail by Commander MacMillan in his book, only a brief description is given here. The launch is brought to rest in calm water. The " bar " used with the *Depthfinder* is a 2½-in. x 1½-in. light steel channel 11½-ft. long, i.e., 1-ft. longer than the beam of the launch. It is suspended, flat side uppermost, by light chains graduated every 5-ft., as shown in Fig. 2.

By lowering and raising the bar to each of the 5-ft. steps in succession, the echo of the bar at these levels appears on the sounding record. Adjustments are provided for: (1) regulating the stylus speed, (2) setting the transmission line in relation to the sounding scale. When these adjustments have been correctly made, the successive steps of the bar echo will appear on the record in their correct scale positions. The graduated chains from which the bar is suspended having previously been checked against a standard steel tape, there can be no doubt that the echo record is a true depth measurement, when the machine has been calibrated by this method.

The record paper, which is moist on the machine, shrinks somewhat on drying and so the " dry " scale is slightly different from the machine scale. The co-efficient of shrinkage is reasonably constant and the correct scale for office use is determined from the dry " bar-check " record. Depths can be read off to the nearest 3-in., the accuracy attainable when sounding under normal water conditions.

Surveying Instruments.

The surveying instruments used when afloat are:

(1) Survey-Sextant, designed specially for hydrographic work, with x5 erect telescope and tangent screw micrometer reading to one minute of arc.

(2) A Line Ranger, i.e. a double-prism (180°) optical square, for obtaining cross fixes when the shore objects are situated one on each side of the observer.

(3) Prism binoculars, 7 x 50, the large objectives being useful for picking up shore transits, etc., when the visibility is indifferent.

The Hydrographic Survey of the Port of Dublin.

The water area of the Port of Dublin which is regularly surveyed comprises the River Liffey, Dublin Bar, Alexandra Basin, the docks and the shipping berth. It extends from Butt Bridge in the heart of the City to the Bar Buoys in Dublin Bay, a distance of six miles. The river is an almost straight channel increasing in width from 250-ft. between quay walls at Butt Bridge to 800-ft. at the Eastern Breakwater Light and generally maintaining this width for a further four miles out to the open sea. The detail of the survey varies with the area surveyed. The parts of the channel where there is little change of depth from year to year are surveyed by lines of soundings 100-ft. apart. Freshly dredged areas call for greater detail while in the shipping berths, the lines of soundings are 5-ft. to 10-ft. apart. Sounding over sites prepared for the foundations of deepwater quays and jetties calls for special treatment.

The survey of the inner harbour of the port is carried out generally on a series of " sections " or ranges across the navigable channel. These are run on shore transits. Cross-fixes are likewise obtained by shore transits. The layout of the harbour lends itself readily to this simple system as the south side of the river fairway is flanked by a training wall, the Great South Wall, along which the front marks of the river ranges are painted at intervals of 100-ft. from Ringsend Gut to Poolbeg Lighthouse. Natural prominences of the Dublin Mountains, situated some eight miles southwards, serve as backmarks and the combination gives a series of 143 nearly parallel ranges across the river, permanently set out.

Before the coming of the echo sounder, the survey of the Port of Dublin was carried out by hand sounding, using the Sutcliffe sounding machine. Restricted by the necessity of obtaining true " up and down " soundings with the leadline, procedure was slow and confined to the slack tide period. Working under these conditions, the booking of cross fixes, sextant angles, etc., was not subject to any great haste.

The echo sounder, with its continuous bottom record, permitting a faster launch speed and with operations not so restricted by tidal movement or currents, obviously required an improved cross fixing and booking technique. As all the areas of the port are surveyed at least annually, the principle of the systems which were evolved was the " standardisation " of all cross fixes and the reduction of booking to a minimum.

Standard " Grid Charts " were drawn for each area of the port and " standard cross fixes " were worked out for each river range and compiled for permanent use in schedule form, the " Cross-range Schedule." The Grid Charts, of course, show positions only; those of the river show cross ranges and cross fixes numbered to correspond with the cross range schedule.

The objects on land used for the cross fix transits are numerous in the Port of Dublin. They comprise lighthouses, perches, chimney stacks, church spires, etc. Their precise locations have been found by triangulation and their positions used for compiling the grid charts. Topographical features are obtained from existing land surveys.

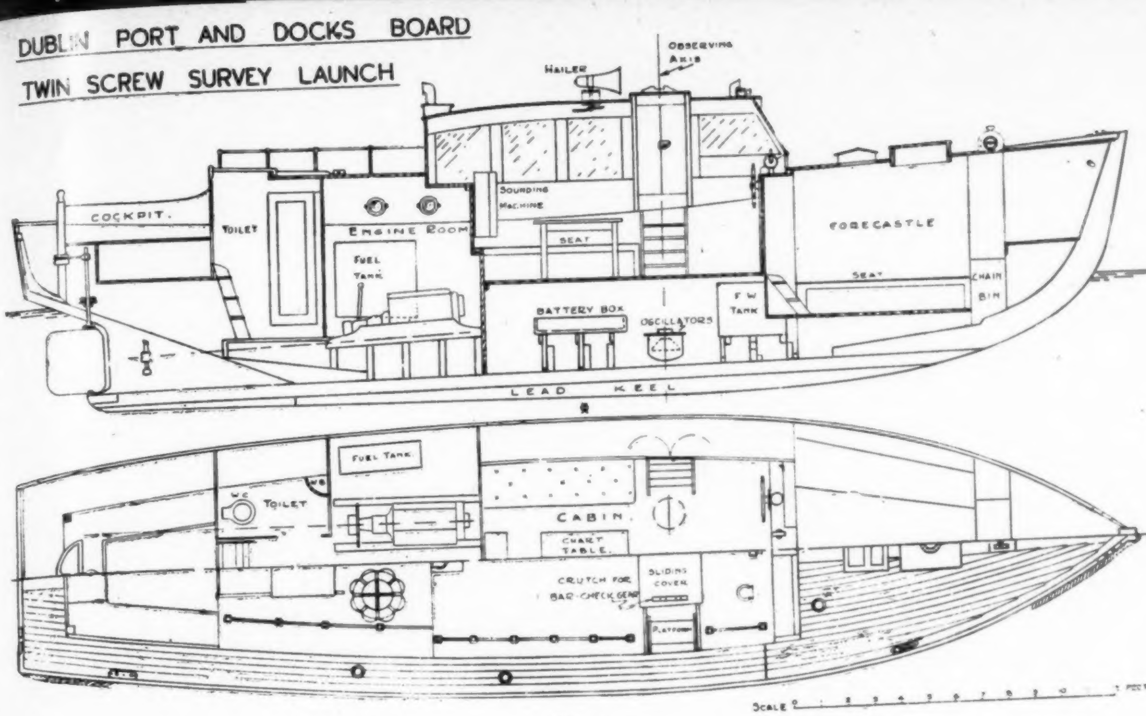


Fig. 1.

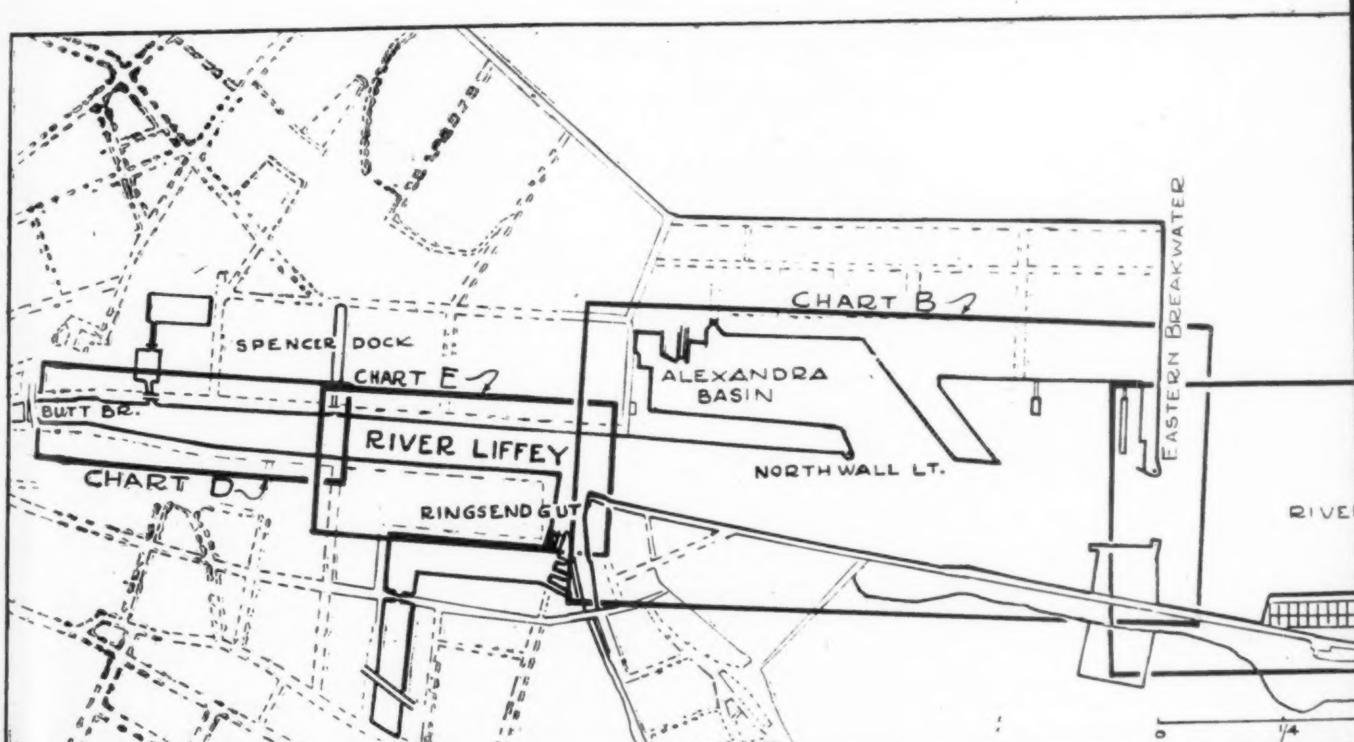
Fig. 1. The Dublin Port and Docks Board Survey Launch *Depthfinder*.

Fig. 2. The Bar-Check method for calibration of the Echo-Sounder.

Fig. 3. The Port of Dublin showing the five chart areas.

Fig. 4. Part of the Grid Chart A.

Fig. 5. Part of the finished Chart A.



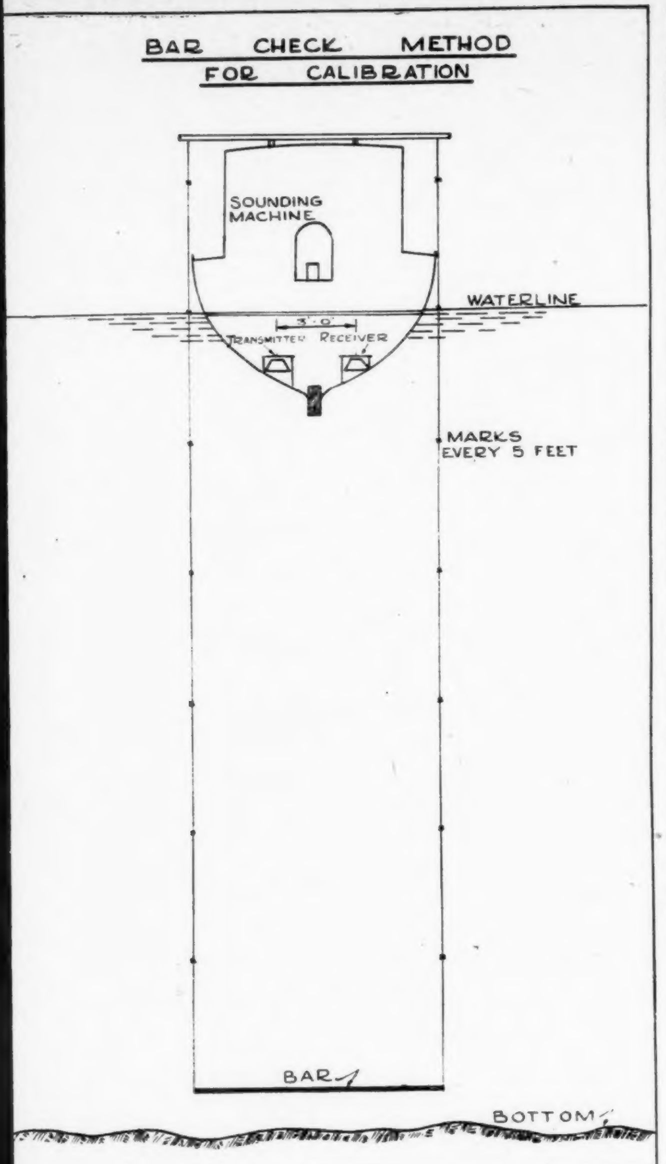


Fig. 2.

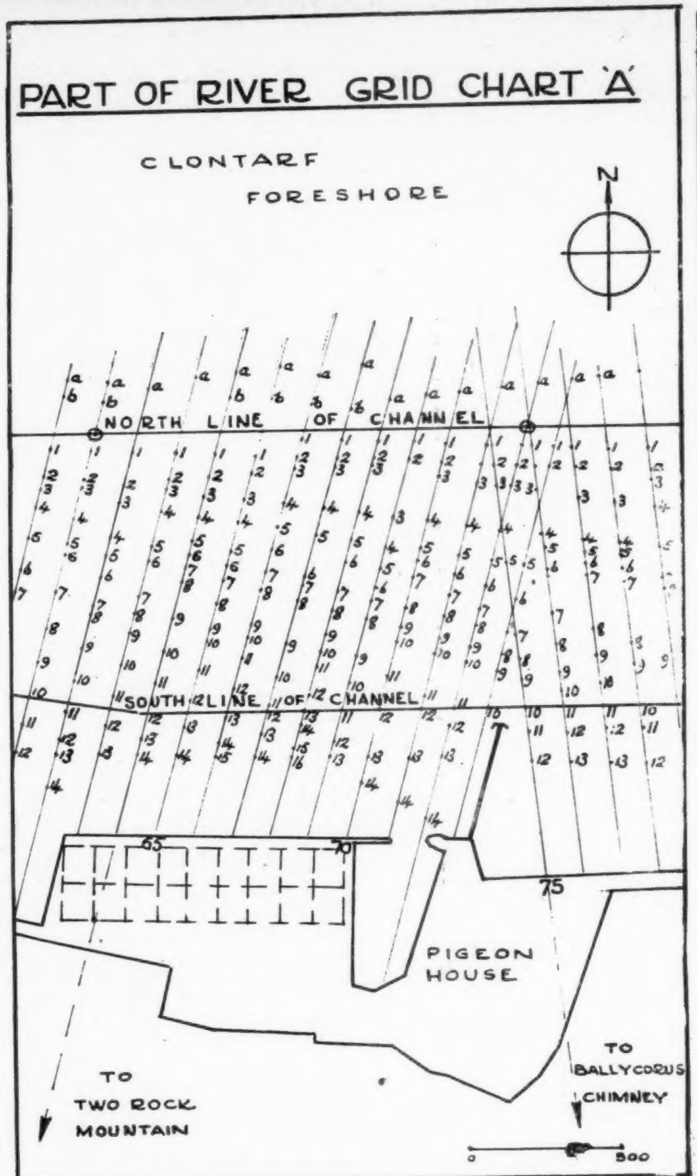
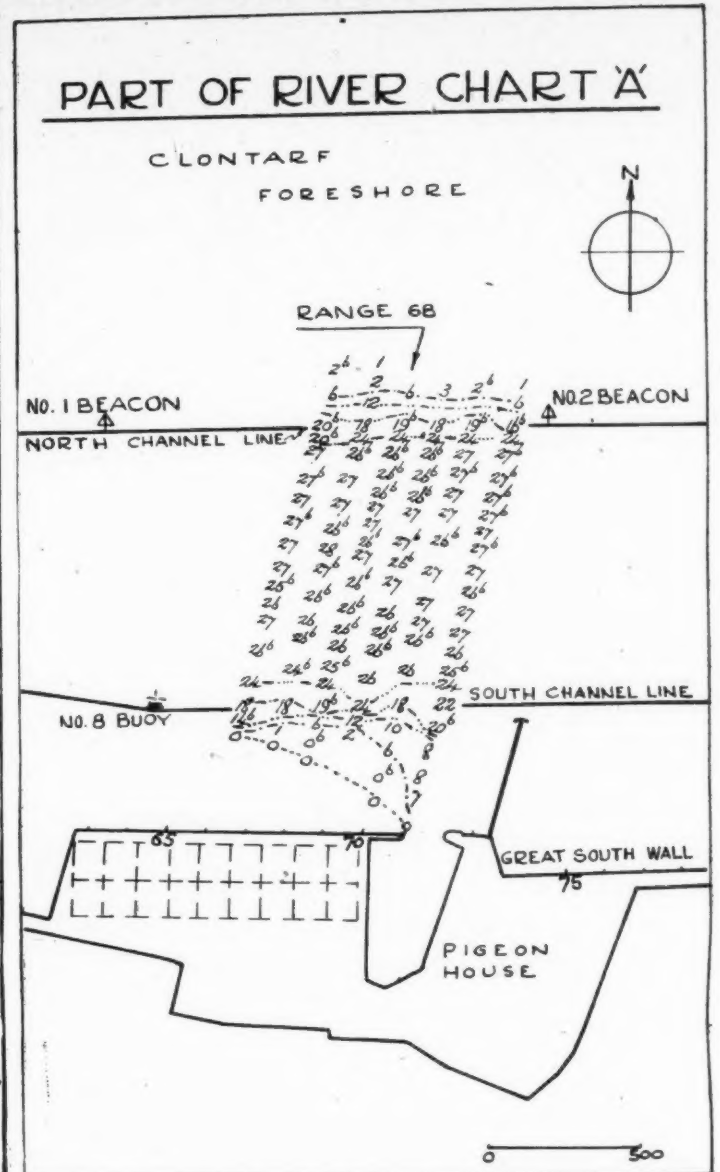


Fig. 4.



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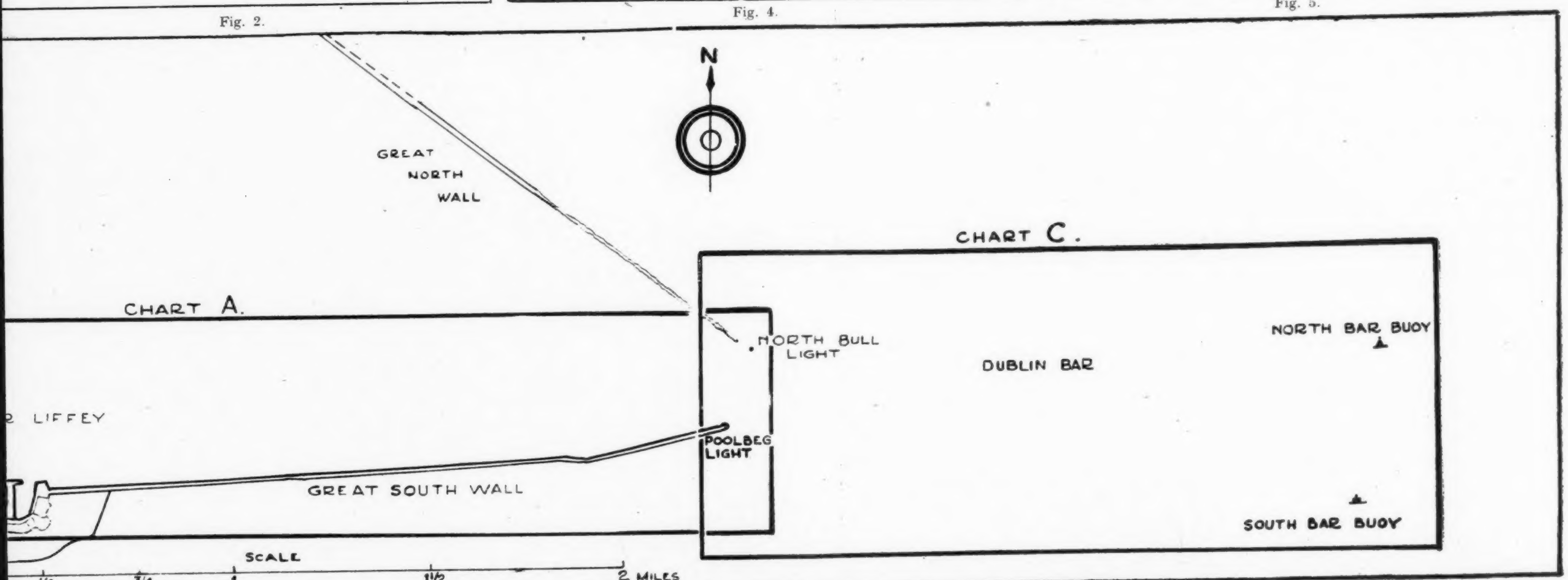

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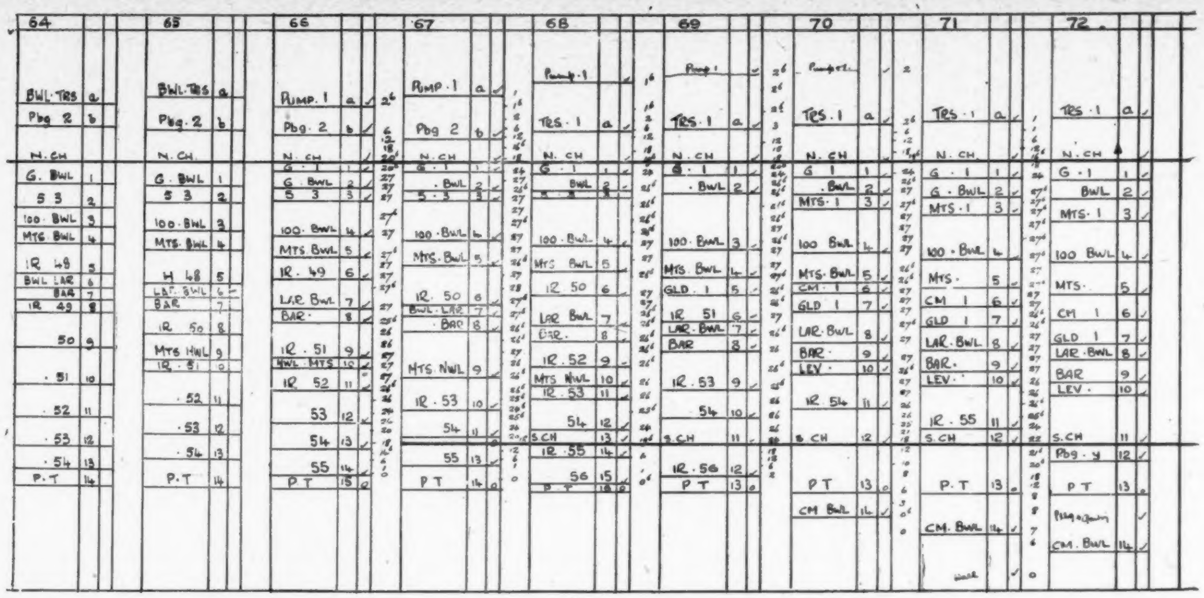

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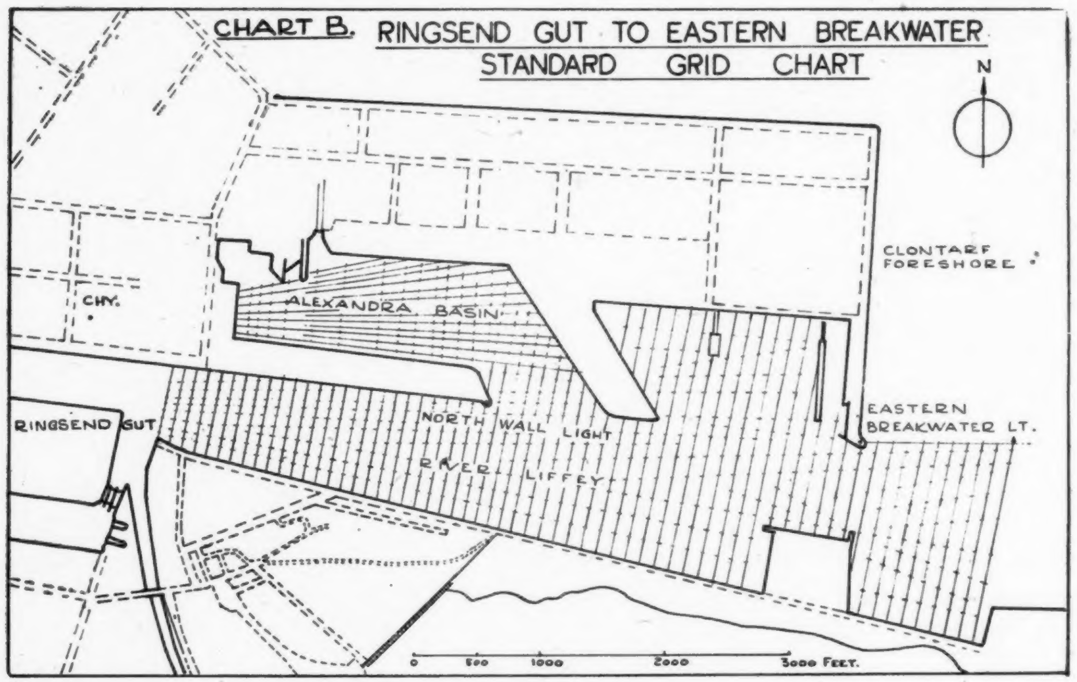

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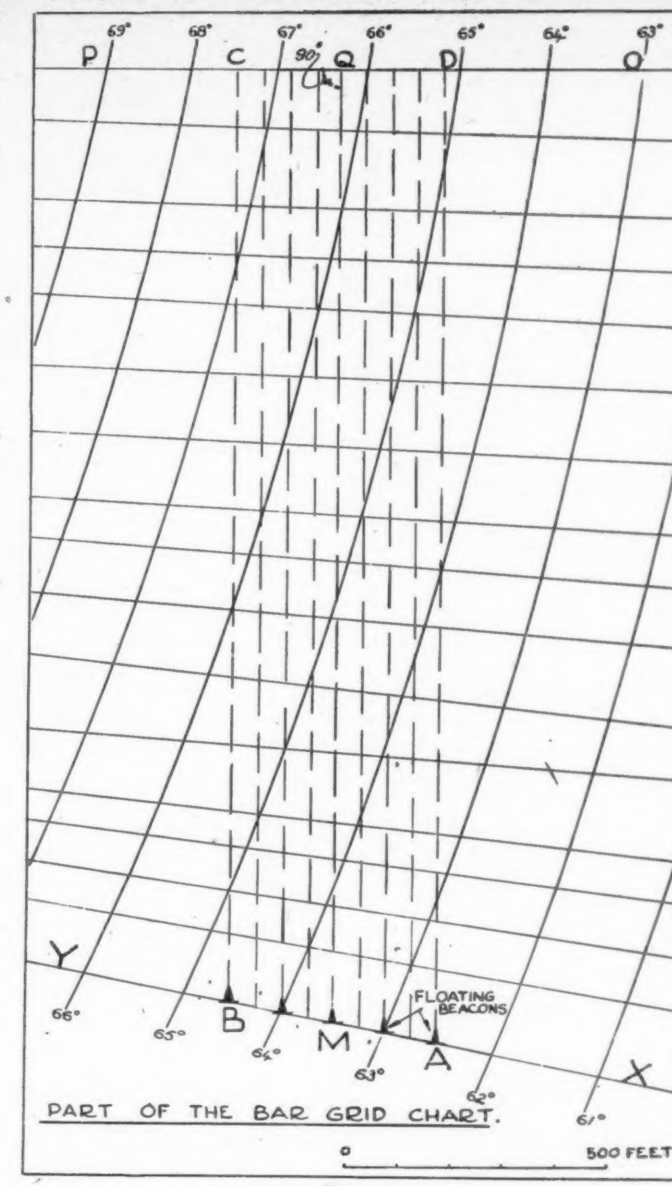
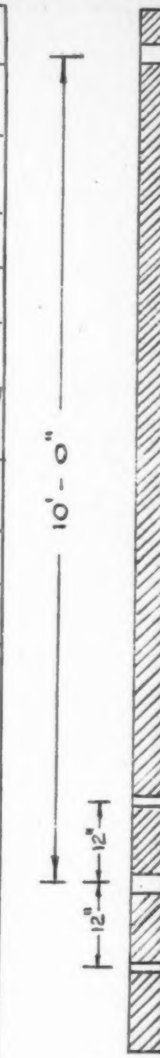


Fig. 10.



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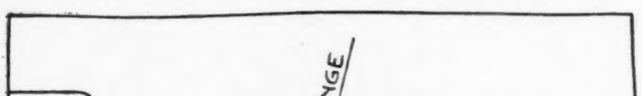

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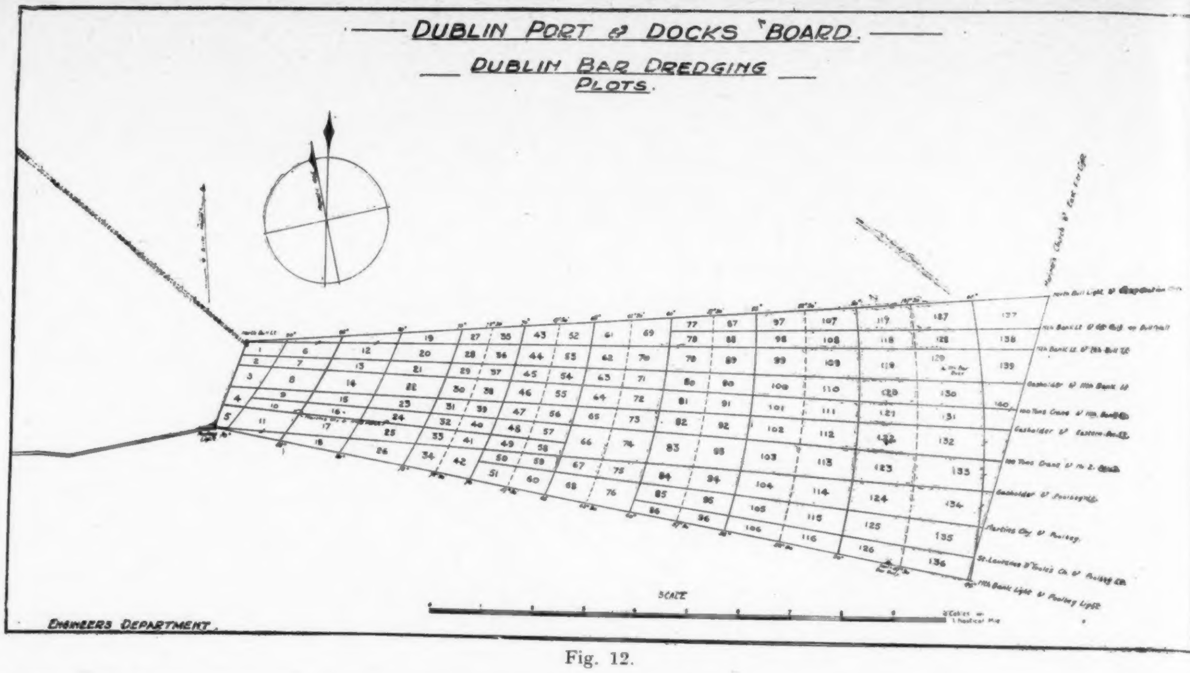


Fig. 12.

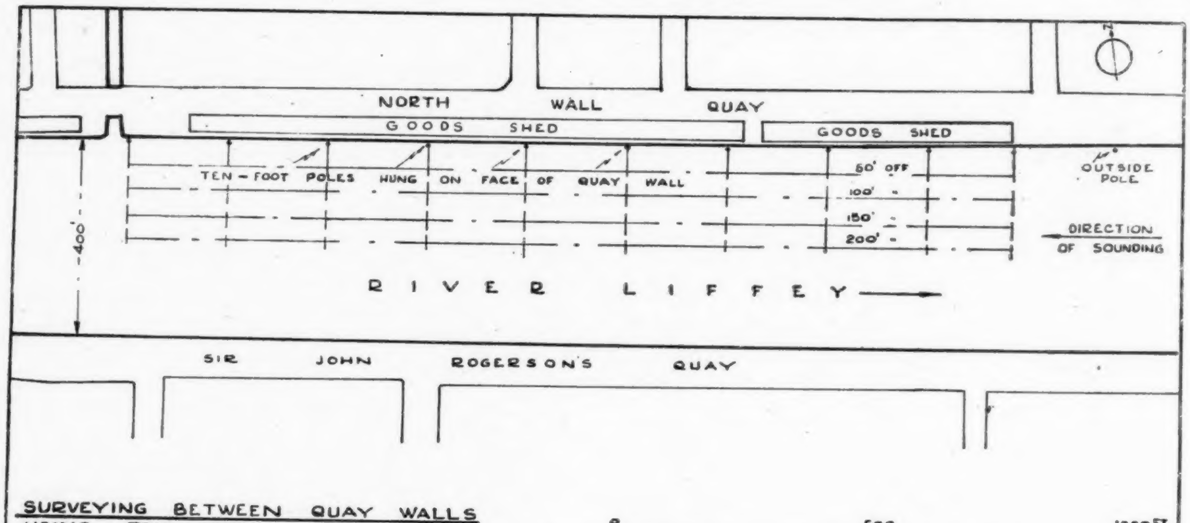


Fig. 13.

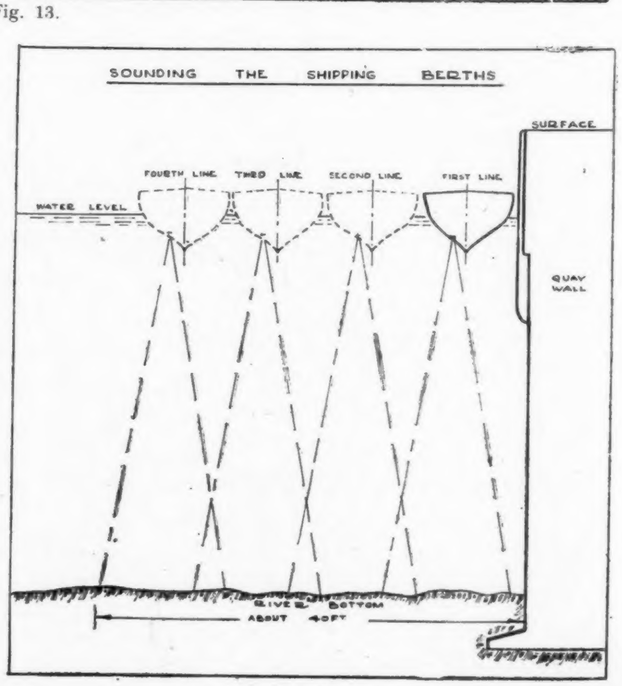


Fig. 14.

the cross-range schedule for Chart A.

rid for Chart B.

ross Fix.

rid for Dublin Bar, Chart C.

the Bar Grid Chart, showing the method of using floating beacons
vide steering transits.

Foot" Pole.

ar Dredging Plots.

ying between Quay Walls, using Ten-Foot Poles.

ng the shipping berths.

Hydrographic Sounding and Surveying—*continued*

The port (Fig 3) is divided into five charts as follows:

	Chart	Scale	Lines of Soundings
A	River Liffey, Eastern Breakwater to Poolbeg Light. Ranges 53 to 143.	1/5280	100-ft. apart.
B	River Liffey, Ringsend Gut to Eastern Breakwater. Ranges 1 to 60 including Alexandra Basin.	1/2500	50/100-ft. apart.
C	Dublin Bar. Poolbeg Light to Bar Buoy.	1/2500	40/50-ft. apart. following Dredging Contract.
D	River Liffey, Butt Bridge to Spencer Dock.	1/1250	50-ft. apart.
E	River Liffey, Spencer Dock to Ringsend Gut.	1/1250	50-ft. apart.

In addition, there are four separate charts showing depths in the shipping berths, alongside the quays.

Chart A. Eastern Breakwater Light to Poolbeg Light.

This is the principal chart of the River group and it covers a long stretch of the river channel where the greater part of the maintenance dredging is done. The standard grid chart for this area, Ranges 53 to 143, is drawn to a scale of 440-ft. to one inch. Part reproduction of this grid chart is shown in Fig. 4. The corresponding part of the cross range schedule is shown in Fig. 6. Each column in the latter is drawn to scale; thus the distances between the cross fixes described in the schedule are directly proportional to the actual distances between them on the range and hence to the distances between the fix-marking lines on the echo-record.

The grid chart is kept in the office and photo print of the cross range schedule (the originals are on tracing linen) is brought on board the survey launch. Procedure when sounding is as follows:

The echo sounding machine, having first been calibrated by a "bar-check," is prepared and switched on and thereafter tended by an assistant who checks machine speed, logs time, etc. The launch is brought to the northernmost point of the first range to be sounded. One engine is cut out and the other regulated to give a suitable sounding speed. A steady course is made across the river with the range number on the Great South Wall in line with the appropriate backmark. The Surveyor refers to the standard schedule for the particular range and as each crossfix transit comes on he presses a remote control fix-marker button. The corresponding series of fix-marking lines are thus drawn on the echo record and the schedule is marked off accordingly, an "0" being given to the fixes which have been covered by shipping, smoke, etc., and consequently missed. When the end of the range is reached, the launch, using two engines, is turned "on its heel" on to the next range, which is treated similarly but in the reverse direction. (Plate 1 shows a typical Bar-check record.)

As already stated, the distances between the fix-marking lines on the echo record are in proportion to the distances between the cross fix lines on the schedule. Their sequence and irregular pattern permits easy identification, therefore it is not necessary to number them on the moist record while sounding; this is done later, on the dry record. "North Channel" and "South Channel" lines are always given a double-push on the fix button, consequently a double line appears for each on the echo record, giving definite identification. Plate 2, being the echo record of Range No. 68 across the river, if compared with the corresponding schedule, will illustrate these points.

Over freshly dredged areas, additional lines are run between the standard ranges and across them, for the purpose of a more detailed examination.

In the subsequent office work, the Port L. W. Datum is drawn on the echo record and the reduced soundings are scaled off. They are entered, in the first instance, not on the chart but in soft pencil in the right hand column of the cross range schedule. Positions between the cross-fixes are simply interpolated. When the cross range schedules for the whole area are completed in this manner, the chart proper is drawn on tracing linen pinned over the grid chart. The numbered grid positions can be seen through the tracing and the corresponding soundings are inked in accordingly from the cross range schedule. The chart is completed by the addition of topography, contours, scale, title and all other relevant information and photo-print copies are taken off as required. Fig. 5 shows a portion of the finished chart corresponding to the grid in Fig. 4 and the schedule in Fig. 6.

Apart from the simplification of the processes of booking and plotting fixes the standard system described has other uses:

(1) The large scale of the cross range schedule permits soundings to be plotted in greater detail, giving complete information and at the same time enabling a typical selection to be transferred to the chart while maintaining the character of the depths.

(2) Shoaling areas become apparent as the soundings are plotted on the schedule without having to wait for the finished chart.

(3) The standard ranges and cross fixes are also used to position the dredgers. In addition to the ordinary chart showing an area to be dredged, the Dredgemaster is given a photostat copy ("copycat") of the relevant part of the completed cross range schedule, which shows him the soundings in detail with their precise locations described by range number and cross fix.

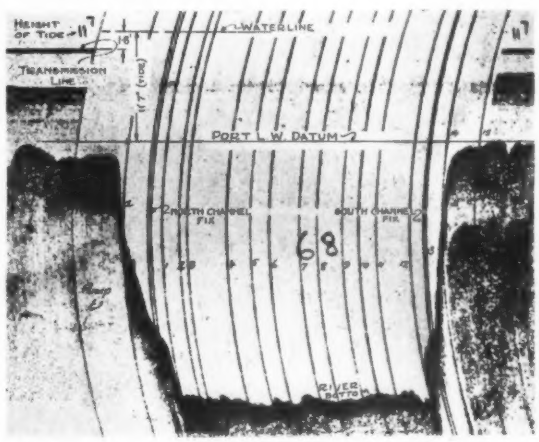


Plate 2. Echo-Sounder Record of River Liffey Range No. 68.

Chart B. Ringsend Gut to Eastern Breakwater.

Drawn to a scale of 1/2500 this chart covers the river from Ringsend Gut to the Eastern Breakwater, and includes Alexandra Basin (Fig. 3, Chart B). In general, the mehtods used for surveying this area are the same as for Chart A.

Standard cross ranges 1 to 60 cover the river portion, for which standard schedules are compiled and a grid of simple transits and cross fixes is used for Alexandra Basin. Fig 7 is a reproduction of the grid chart for this area.

As the greater part of this chart comes within the built-up area of the port, cross fixing shore transits with the two objects in the same direction are very few. Consequently the 180° double optical square is brought into use, giving fixes of a type shown in Fig. 8, that is with the observer between the two objects sighted. Practically all the positions on this chart are obtained by 180° cross fixes.

Chart C. Dublin Bar.

The title "Dublin Bar" describes the area of Dublin Bay situated outside the mouth of the River Liffey and extending eastward from Poolbeg Lighthouse to the Bar Buoys (Fig. 3, Chart C). The area measures about two miles from West to East and about three-quarters of a mile from North to South. The fairway runs eastward through this area to beyond the Bar Buoys, where the depth increases naturally. The term "Bar" no longer applies in the strict sense of the word as the bar was gradually scoured away following the construction of the Great North Wall (North Bull Wall) in 1825. As a result of the continuous scour action and

Hydrographic Sounding and Surveying—continued

maintenance dredging by the Board's suction dredger *Sandpiper*, the depth in this area has been comparatively stable. Prior to extensive contract dredging commenced in 1947, the even nature of the bottom permitted surveying to be carried out on an open grid of transits spaced about 120/160-ft. apart. These ran generally East and West over the Bar area and positions on the transit lines were fixed by sextant angles, i.e. "transit and angle." The two shore marks for the sextant angles are conveniently placed in order to be suitable for covering the whole area and this system was developed to establish a "Bar Grid Chart," comprised of transit lines and sextant arcs (Fig. 9).

In 1947 suction dredging by contract was commenced with the object of removing 1,000,000 cublic metres of material and increasing the navigable depth of the Bar by 2-ft. The progress of the work and the type of dredging, necessitated a detailed survey; consequently the Bar Chart, previously drawn to a scale of 1/5280, is now drawn to 1/2500. The same grid is used but the lines of soundings are 50-ft. apart and run North to South across the fairway.

Running lines of soundings in the open sea requires an aid to steering if the lines are to follow a regular pattern without overlap or gap. Steering by compass, especially in a tideway, is not sufficiently accurate for this purpose and a fix must be made and plotted before any deviation from the course set is observed. When steering on a transit, however, any divergence becomes obvious immediately and can be corrected.

On Dublin Bar, close transits are not readily available as the coast is situated some five miles to the North and South of the area. Steering transits are, therefore, provided by the use of a set of five small floating beacons anchored in pre-determined positions. The manner of their use is as follows:

Fig. 10 shows a portion of the Bar Grid Chart and A B C D is the area selected for survey. The distance A to B is about 400-ft. The five floating beacons are to be set down in positions evenly spaced from A to B, so the angles of these positions are taken off the Grid Chart.

The survey launch, with the beacons in readiness in the cockpit aft, is brought slowly along the transit line XY, and the beacons are dropped overboard in their pre-determined positions as the appropriate sextant angles are reached. Then the launch is brought to the North side of the area and steered along the transit line OP. This is a true East and West line. Using the sextant set to 90° or the optical square, the launch proceeds until the middle floating beacon M is seen on with the transit marks; i.e. angle MQP is a right angle. At this precise moment, the particular spot of the distant coast which is seen behind the middle beacon is picked up and used thereafter as a backmark for running nine lines of soundings, five "on with" and four between the anchored beacons. These lines run from North to South and are approximately parallel as the backmark spotted is some five miles away.

The beacons are used only as aids to steering. The course made by the launch across the Bar Grid is independently identified by sextant angle as each of the East and West transit lines is crossed (i.e. simultaneous transit and angle) and plotted on a copy of the Bar Grid Chart on board while under way.

The nine lines of soundings complete the survey of the area A B C D. The beacons are retrieved and repositioned for the adjacent section of the Bar area, which is similarly dealt with, and so on.

Dredging Plots.

The Bar Grid is used to divide the complete area into numbered dredging plots, each plot being contained by two transit lines and two sextant arcs (Fig. 12).

All dredging operations on the Bar are referred to the numbered plots and the system of fixing position is common to both dredging and surveying. This is very important as regards Departmental dredging and records and essential in the case of Contract dredging.

Charts D and E. Butt Bridge to Ringsend.

From Butt Bridge to Ringsend Gut the River Liffey is enclosed by the shipping quays. The width of the river for the greatef part of this length is 400-ft. (Fig. 3, D and E). Surveying in this area is carried out on lines of soundings 50-ft. apart, running parallel to the quay walls at distances of 50-ft., 100-ft., 150-ft. and 200-ft. off. "Distance-off" is measured by subtended vertical sextant angles on a series of "ten-foot poles" hung over the face of the quay wall in the spaces clear of moored shipping. The poles are light laths, painted black with four white bands (Fig. 11), the two main bands A and B are 10-ft. apart and the two narrow ones C and D are one foot above and below B. Usually, ten poles are hung within the survey area and another one a short distance outside it (Fig. 13).

With the sextant set at the appropriate "distance-off" angle, the launch proceeds towards the survey area on a course parallel to the quay wall, the distance-off being estimated as a preliminary. The outside pole is picked up with the sextant and as the observer approaches the point on the course which is nearest to the pole, i.e. directly abreast of it, the reflected image of A as seen with the sextant appears in the horizon mirror to rise from below to meet B, falling away again when the nearest point is passed. Should the "distance-off" be correct. A will rise to coincide exactly with B. Should the distance be greater than correct, then A will not rise as far as B; conversely if it should be less than correct, then A will rise above B. The positions of C and D on the pole represent the equivalent of one-tenth of the distance-off, minus or plus, thus enabling any distance error to be judged by the highest point to which A rises without having to adjust the sextant angle and look up tables.

The distance correction is given to the helmsman and the launch enters the survey area at the required distance from the quay wall. As the launch comes abreast of each of the remaining poles in turn the "distance-off" is checked, corrected if necessary and so a fairly straight course is maintained.

The procedure is carried on for four lines of soundings, extending to the centre of the river. The poles are then shifted across to the other quay wall and the same routine used for the other half of the area. The pole positions are marked on an outline working plan and used for cross fixing.

This method of measuring distances has been checked out on land against the tape. Using the survey sextant with the x5 telescope, distances up to 400-ft. can be measured by subtended angles to an accuracy of 1/100, which is sufficient for the short distances used in this type of survey. For convenience when sounding, the 10-ft. pole angles for the distances 50-ft., 100-ft., 150-ft. . . . 400-ft. are engraved on a small brass plate fitted to the index arm of the sextant.

Sounding in this part of the river is carried out during the lower half of the tide, to enable the 10-ft. poles to be hung clear of the water.

Sounding the Shipping Berths.

It is important that vessels lying alongside the quays be provided with sufficient flotation at low water of Spring Tides and hence the berths are frequently checked so that they may be kept to their designed depth. The accumulation of silt is not excessive and can be dealt with adequately by grab dredging. Occasionally, bulky objects are discovered in a berth, having fallen in from a ship or from the quayside and sometimes unwanted articles or material are deliberately dumped, constituting obstructions and sources of danger to shipping.

Although such occurrences are infrequent, they are not always reported and the first evidence of a "foreign-body" may appear on the echo-record.

Berth sounding, therefore, constitutes a search as well as a survey, that is, a complete coverage by echo-sounder of the river bottom for some distance out from the quay wall.

This is accomplished by running a series of lines of soundings parallel to the quay wall and sufficiently close together so that the echo paths overlap to a small extent (Fig. 14).

Occasionally, the bottom record may show up as a double-echo, indicating a mud or silt overlay on a hard bottom. Trenches dredged for the foundation of deepwater quays or jetties usually contain a layer of a foot or so of soft material, which has flowed in from the side slopes. This is readily discernible on the echo record.

On one occasion when sounding a shipping berth, the record of

Hydrographic Sounding and Surveying—continued

the first run close along the quay wall indicated an excessive depth in the berth for a short distance, with a clear horizontal line showing along the bottom echo. This was quickly recognised as the toe of the quay wall deprived of its normal coverage. An examination by diver confirmed this, the exposure of the toe being attributed to the scour caused by running the propeller of a vessel while tied up in the berth.

Datum and Tides.

The Datum to which the soundings are reduced is designated Port Datum and is the level of Low Water of Ordinary Spring Tides. It is the level of zero of the standard tide gauge of the Port cut in the face of the quay wall at Alexandra Basin and it is 1.43-ft. above Irish Ordnance Datum. The rise of tide is 12.8-ft. at Springs and 10.4-ft. at Neaps (North Wall).

An automatic recording tide-gauge is installed in the North Wall Lighthouse and this has provided continuous tide records since 1904. These are the basis of harmonic analysis and tidal predictions worked out for the port by the Liverpool Tidal Institute.

For the reduction of soundings to Port Datum, recordings from the automatic record are used for surveys West of the Eastern Breakwater, Charts B, D and E. For surveys of Dublin Bar, Chart C, visual readings on a tide pole established at Poolbeg Lighthouse are used. For Chart A, Eastern Breakwater to Poolbeg, an interpolation between the North Wall and Poolbeg levels is used. The range of the tide at Poolbeg is 0.4-ft. less than that at North Wall Lighthouse; there is no appreciable difference in time. During the course of sounding operations, occasional visual check readings are taken on tide poles permanently established at various points in the port.

Personnel.

With the exception of Dublin Bar, all the hydrographic survey of the port is carried out by a team of two. Surveyor and Assistant. Another observer is necessary on the Bar. The Survey Launch has a crew of two, helmsman and sailor, with an extra sailor when the floating beacons are being used on the Bar.

Bibliography.

Precision Echo Sounding and Surveying by Commander D. H. MacMillan, R.N.R., Hydrographer to the Southampton Harbour Board, to whom the Author is indebted for expert advice on several occasions.

New Dock Gates for the P.L.A.

Fitted to King George V Entrance Lock

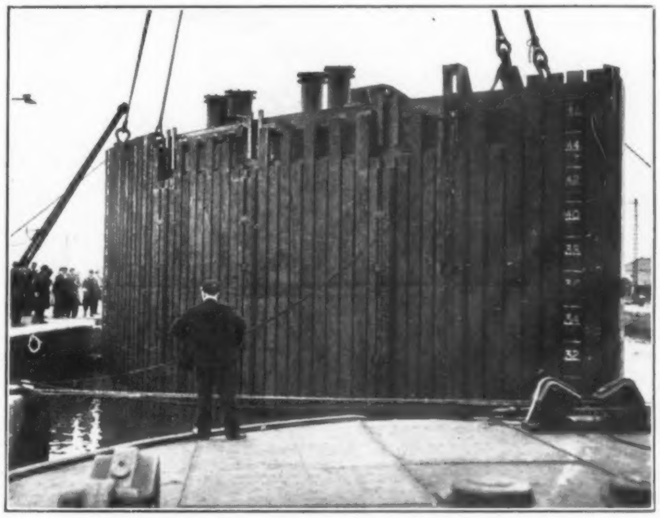
From the same slipway which saw the launch of many Tank Landing Craft during the War, a somewhat different type of launch took place towards the end of May, when a pair of all-welded dock gates, built for the Port of London Authority, were launched into the River Tees. The gates, which were designed and built by Messrs. Head Wrightson & Co., Ltd., Stockton-on-Tees, were then towed to the mouth of the river, where a larger tug took over to continue the journey down the North Sea to the River Thames.

The gates are for use in the King George V Dock, and are interchangeable with any of the three positions of the 100-ft. wide entrance lock. On arrival at site, the gates were manœuvred into a vertical position by means of the P.L.A.'s floating crane, "London Mammoth," and left temporarily alongside one of the dock walls. Then the various temporary water-tight covers, over the scuppers, air vents, ejector pipes, etc., were removed. The gate was then trimmed with water ballast to a depth of approximately 10-ft. in the mitre end chamber, and 3-ft. 6-in. in the heel post end chamber, as it is necessary when stepping to have the mitre end of the gate slightly lower than the heel post end.

After removal of the existing gate the "London Mammoth" again took hold of the new gate which was brought round to its new position. After careful manœuvring, so that the heel post fitted snugly into the hollow quoin, the gate was gently lowered into the water. Before finally landing on the pintle a diver was sent down to check against any obstructions, after which the gate was finally lowered until it was seated on to the new pintle. The U bolt which fits round the top gudgeon was then placed in position, thus holding the gate back in the quoin. The temporary wire strop which had held the roller attachment was then cut so that the roller dropped into the roller path and temporary packings were inserted on top of the spear rod so that some of the weight of the gate was transferred by the roller on to the roller path.

All that then remained was to pump out the water ballast, to fit the sluices and top platform, and to complete the fendering.

It is interesting to note that the weight of each leaf of this welded design is 240 tons against that of approximately 350 tons of the existing riveted type. Each leaf is 58-ft. long x 49-ft. 6-in. deep x 7-ft. 3-in. mould width and consists of 17 plate ribs or decks, suitably stiffened where necessary. The skin plating is butt jointed and is composed of eight strakes on both the flat and curved sides. Vertical stiffness is provided by five plate diaphragms extending the full depth of the gate, the centre diaphragm being watertight for its full depth, the two outer being watertight between the top of the air chamber and the second lowest deck thus forming four



The gates being stepped into position at entrance to King George V Lock.

tanks in the lower air chamber and two tanks in the upper tidal chamber of the gates. The space between the bottom and second decks is also tidal on the pressure side.

The heelpost and mitre post are built from plates, welded in the form of a channel and joist sections respectively, the heel, mitre and sill timbers being of greenheart. A central core plate with stiffener brackets at deck centres is welded directly to the web of the heel post. Two manhole trunkways extend from the top deck to give access to the lower air chambers. Three sets of hydraulic sluices, each 3-ft. 5-in. x 2-ft. 11-in. opening, and a hydraulic ejector, with valves to draw from each of the four tanks of the air chambers are provided. The upper half of each leaf is completely sheathed with elm whaling and fenders.

Although the gates are of the buoyant tank type, rollers have been fitted to suit the existing roller paths. A crocodile arm, or lever, also of welded construction, is provided to operate the gate from the existing hydraulic machinery.

Workmanship throughout has been under Lloyd's supervision and they also certified the hydraulic pressure tests on the tanks of the gate.

Change of Date of Publication.

Owing to reorganisation in our printing department, we have found it necessary to alter the publication date of "The Dock & Harbour Authority" from the 1st to the 15th of each month. The change will take effect as from our September, 1952, issue.

New Type of Fender for Jetties & Wharves

By M. SHWARTZ, I.C.

Though considerable achievements have been made with gravity fenders in past years, there are still some difficulties which have yet to be overcome.

With most existing types of fenders there are still large horizontal forces involved in berthing, which demand a heavy construction of the jetty in proportion; the absorption of longitudinal forces is limited; and the absorption of the energy of the ship, made by direct engagement with the lifted weights which are very big in proportion, cause difficulties in erection and can be of danger to small boats; further, the workability of the present fenders is constricted in rough seas (owing to the fact that the weights have to be moored).

With all this in view, the fender construction outlined below has been designed.

The fender is composed of a vertical frame which the ship in berthing presses against, the frame is pivoted near the top and bottom to links, which are also pivoted to the berth. The upper and lower links are arranged to form a parallel linkage, by which arrangement all movement of the frame is in parallel vertical planes. The lower link is in the form of a bell-crank, of which one arm forms the lower of the parallel linkage and the other arm is arranged to be substantially horizontal when in its normal position. Usually the latter arm will be longer than the link arm, thus a small downward and horizontal movement of the frame will produce an appreciable vertical lift at the end of the longer arm; the rate of the vertical lift is predetermined by the ratio of the length of the two arms.

The energy of the ship is absorbed by lifting a plurality of superposed weights, connected to the end of the bell-crank horizontal arm by means of chains.

In order to minimise shock in the engagement of the ship with the fender frame, the weights are lifted gradually, one from the other in succession, and this is arranged by means of loose chains that connect one weight to another. It is also desirable in minimising the shock, that the uppermost weight will be of least value and the others of successively greater value.

The weights can lie on the sea bed, but in cases where there is considerable silt, or deep or rough seas, a platform is provided with housing rails wherein the weights may rest.

Another arrangement is suggested for the weights in case of continued inspections being necessary, then the weights are suspended from the deck and the lifting arm pushes the weights upward, one toward the other. The frame structure is of small weight in proportion to the superposed weights and therefore the reduction of the energy absorbed, caused by the downward movement of the frame, is very small.

To minimise the longitudinal forces acting on the jetty, resulting from the ship moving across the face of the fender frame, a plurality of rollers, for direct engagement with the ship, projecting from the frame and supported by it for free rotation about vertical axes, is installed. The rollers may comprise one vertical column or more as necessary; the rollers are disposed at intervals along the length of the frame, between the positions of the pivoted links, each roller may consist of a steel spindle with its peripheral surface covered with wood, ropes or any other suitable material. To increase stability of the fender, diagonal bracings are provided.

The fender members can be manufactured of steel or of pre-stressed pre-cast concrete.

In a fender unit (see Fig.) where a = 8-ft.; b = 15-ft.; and the total weight of seven concrete blocks is 22.5 tons (submerged weight) and the play between the weights is 4-in., with a 45-in. horizontal movement of the fender frame which causes a lift of the uppermost weight to be 100-in., the absorption of energy is 2,000 ton-inches, which permits berthing of ships of from 20,000—28,000 tons at a berthing speed of 1-ft. per second, Hmax in that case is 50 tons.

It may be concluded, that from the above fender construction the following advantages will be obtained :

(a) The horizontal forces acting in normal direction on the jetty, are reduced in most cases to between one-third and one-quarter of the forces acting on the jetty with the present fenders.

(b) Longitudinal forces are minimised, by the installation of rollers in the frame.

(c) The lifted weights are of small units and total much less than the present weights (between one-quarter and one-fifth of present weights).

(d) The fender is in full efficiency in all weather.

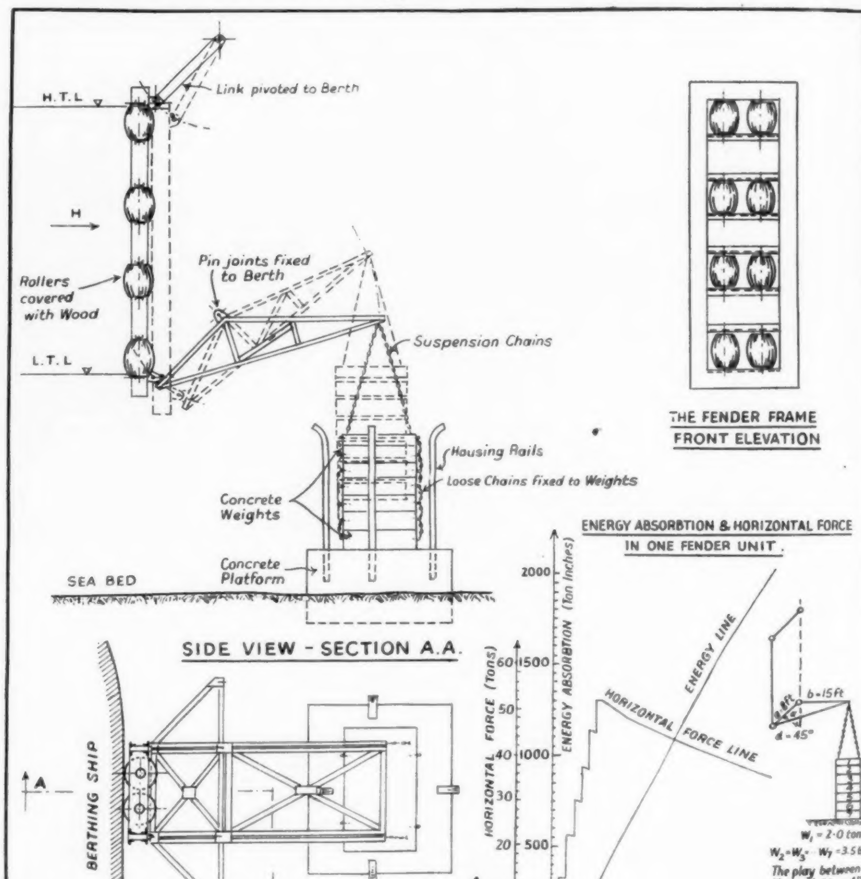
(e) The engagement of the ship is done with a small mass in proportion, therefore the same fender unit is suitable to all sizes of ships, from the smallest to the largest, with small danger of damage to the ship.

(f) Because of the rollers, renewal of rubbing materials will be less frequent.

(g) The fender is composed of lightweight members in proportion and therefore there would be no great difficulty in erection.

(h) By reducing the forces acting on the jetty and reducing the weights, a lighter construction of the jetty can be designed, and in some cases, even a saving of heavy strong points or dolphins is possible.

From these advantages it appears probable that the installation of this type of fender may considerably reduce expense in the construction of the jetty, and in the maintenance costs. (A patent has been applied for.)



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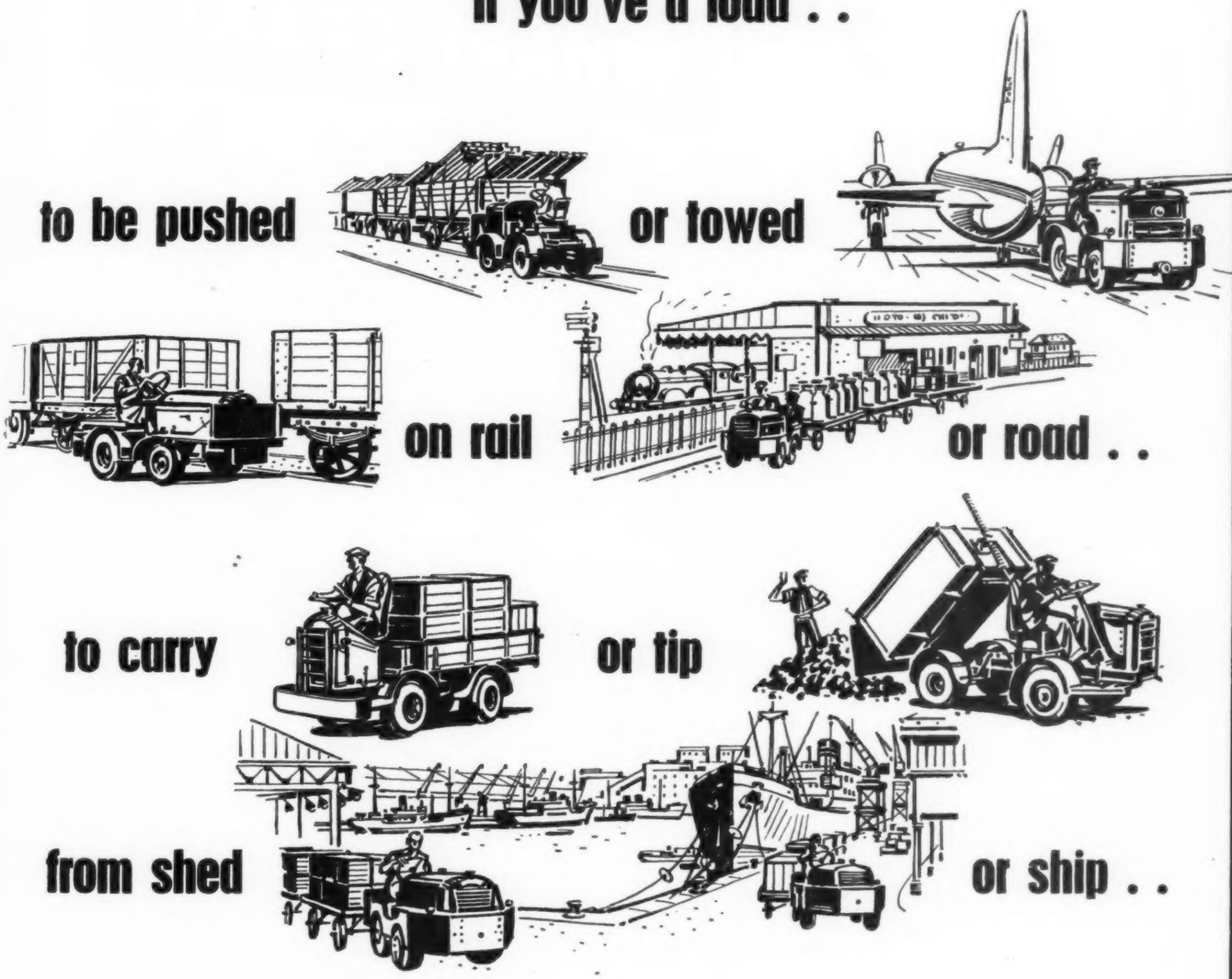

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Port Economics

Part 7. Port Charges

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[**An Additional Note on Part 6—Port Labour.**

Since last month's contribution appeared, the fifth annual report of the National Dock Labour Board has been published. It shows that the total workers registered in the last quarter of 1951 was 82,360, of which 76,911 men were on the live register. The number of local boards rose from 24 to 25. Gross earnings of daily workers averaged £9 16s. 6d. a week in 1951 against £8 12s. 10d. in 1950. The following points may also be worth noting in amplification of last month's article : (1) The Labour Board took over the Ministry schemes for Merseyside and Clydeside as well as the functions of the National Corporation; (2) the weekly guarantee of £4 8s. relates only to Group A men under the age of 65; (3) the dormant register includes men transferred from the suspense who, as the result of sickness or injury, have been on the suspense for more than 16 weeks; (4) although six months is the minimum period of employment if the employer is to secure the benefit of the lower percentage payment to the Board, weekly workers and their employers are, in fact, free to part company at any time; (5) the four per cent. paid to the Board in respect of weekly workers includes the sum of £12 7s. 6d. borne by the Board in respect of annual holidays; (6) increased attention is now being paid to pre-entry training and the training of new entrants; (7) in most ports, the continuity rule is reciprocal—that is, a man once set on is not only entitled but required to follow the job through; (8) the percentage of men proving attendance in 1951 was six per cent. of the total register: the Board is budgeting on an average figure of 8.3 per cent. for 1952, but the figure to date this year has been much heavier than this].

In port operation, the word "dues" is usually applied to payments required by the port authority from shipowners and traders in return for the temporary use of static facilities, created, improved, controlled and maintained by the port authority. "Tolls" are most often demanded for the periodic use of an artificial transport track—e.g. a railway line or a canal. The term "charges" is general in its application but is commonly used with particular reference to the price required by the port authority for services rendered—as distinct from facilities provided—in connection with the handling of cargo, for example, between ship and shore or into and out of dock warehouses. The word "rate" is sometimes used interchangeably with "due" but, in many places, "rate," suitably described, also relates to prices for different services performed.

Dues may be divided broadly into two main classes—dues on vessels and dues on goods. Dues on vessels are otherwise known as tonnage dues, the usual basis of payment being a certain sum per net register ton. The net register tonnage of a ship is her gross register tonnage less an allowance in respect of engine room space, crew accommodation and some other factors; the gross register tonnage is the vessel's cubic capacity expressed at the rate of one ton for every 100 cubic feet. As against the general use of net tonnage for purposes of dues payment, it may be noted that drydock dues are sometimes payable on gross tonnage. Net register tonnage commonly averages between 58 and 63 per cent. of gross register tonnage; whilst deadweight (or cargo-carrying capacity) is usually two to three times greater than net register tonnage. Many cargoes stow at very much less than 100 cubic feet to the ton, for example, coal is 40 to 49, iron ore 16 to 20 and wheat 47 to 50.

Tonnage dues are charged in respect of (some or all of) lighthouses, protecting piers, the dredged approach channel, the dredged river channel, the use of moorings provided at buoys, the use of a river quay berth, and/or the use of enclosed wet docks and public drydocks. Elements in respect of certain services are sometimes included in the tonnage dues payment, e.g. assistance, if required, of dock pilots or dock mooringmen or dock tugs. At some ports, the charges in respect of tonnage dues are compounded and expressed as one rate in respect of all port facilities with a second rate in respect of all dock facilities if used; the port due is sometimes known as the harbour or river due. At other places, a separate charge is made for each of the various facilities provided.

Tonnage dues at United Kingdom ports are most commonly based upon statutory powers conferred upon the port or dock authority by private acts of Parliament as supplemented from time to time by Orders made by the Minister of Transport. The acts lay down scales of maximum charges and it is the practice of port authorities to charge less if they can afford to do so. On the other hand, when wages and maintenance costs rise steeply, or staple trades fall away, the statutory maxima at United Kingdom ports have often proved to be insufficient to keep the ports in efficient action, and, in consequence, greater charging powers have been authorised by Ministerial Order.

The actual amount per net register ton demanded by a port authority from a visiting ship is liable to be affected by the following influences:—

(1) The original, historical basic rate or rates.
(2) The amount of capital development undertaken by the authority.
(3) The method of financing capital developments.
(4) The cost of annual maintenance of the facilities.
(5) The extent of the statutory powers granted originally, and from time to time, by the legislature.
(6) The value of the country's currency in terms of commodities.
(7) Changes in the nature and volume of the port's trade.
(8) The level of charges at potentially competitive ports.
(9) The length of voyage just completed or now contemplated by the particular ship.
(10) The nature and purpose of the ship's visit.
(11) The amount of cargo loaded or discharged in relation to the ship's total capacity.
(12) Charges made to similar ships in similar circumstances.

Before considering the above-given points in detail, it may be useful to remark that a port authority charging a ship tonnage dues provides, in some degree, a rather specialised example of the operation of price-mechanism. As defined by Cairncross, price-mechanism is the mechanism by which prices adjust themselves to the pressure of demand and supply and in their turn operate to keep demand and supply in balance. But it is axiomatic that price-mechanism only operates perfectly in an entirely free market —and manifestly the market in port facilities is far from being entirely free; it would only be so if all port authorities and all shipowners could exercise complete freedom of choice, as between one another, in the letting and hiring of port facilities. Because this is not so, and never could be so, various pressures of a quasi-monopolistic or restricting nature are continously at work, e.g. the liner owner prefers to use, and is largely bound to, his base ports; the tramp owner goes where his charter requires him; the coal carrier must load at coal shipping ports which in turn are as close as possible to existing coalfields and he must discharge at specially-equipped quays often adjacent to gas works or power stations; the oil tanker voyages from the oilfield terminal to the ports with oil discharging and storage facilities; the attraction of established commodity markets and the influence of hinterlands are always playing their parts; and, at the price end, there are the statutory maxima always setting the ceiling for the port authorities in the matter of prices to be charged. Other influences, tending towards the narrowing down of freedom of choice, have been mentioned in earlier chapters.

Port Economics—*continued*

The historic basis.

If we could go back far enough in the financial history of any port we should come to the occasion when it was first decided that ships must begin to pay something for the use of the harbour or river. Some of these old, original tonnage charges are on record —and they often came into being because the natural state of the harbour was no longer good enough for the needs of shipping and so money had to be spent on artificial works, improvements or remedial measures. It is said, however, that the earliest tonnage due in England was imposed by Edward II and was not of this kind; rather it was an impost on wine-carrying vessels designed to provide a fund for the defence of the realm (E. W. Blocksidge "Hints on the Register Tonnage of Merchant Ships"). As examples of the more usual kind, the cases of Liverpool and Sunderland may be cited. The first capital expenditure carried out at Liverpool was between 1709 and 1715 when the town council, empowered by Act of Parliament, raised £6,000 to build the first dock. This sum was later increased by a further £8,000, and rates varying from 2d. to 1s. 6d. per ton were authorised to be levied on shipping using the dock. At Sunderland, in 1669, Edward Andrew was granted letters patent by Charles II to build a pier, erect a lighthouse, cleanse the harbour and to raise contributions for these purposes. Prior to the passing of the Merchant Shipping Act, 1854, which introduced the net register basis, tonnage dues were commonly charged on tons burthen, i.e. carrying capacity expressed in weight.

Many other instances of the early imposition of tonnage dues might be quoted but the initial motive and subsequent pattern of events are much the same everywhere. We may suppose that the promoters of the first port improvement schemes formed an idea of what the work might cost to carry out, and thereafter to maintain in good order, and, balancing these estimates against the volume of shipping using the port plus any additional trade they hoped to attract, they thus arrived at a levy which they calculated would produce enough money to finance the original work and provide the annual maintenance costs. If there be any basic theory of tonnage dues, it must be something of that kind. There are also early records of charges levied upon goods passing through seaports and this part of the matter will be referred to later in these notes.

Capital development.

Once the great task of port development got fairly started, it proceeded apace—driven on by the mounting volume of seaborne commerce, the increasing number and size of ships, the industrial revolution, the coming of the railways, the rise in living standards and the resultant growth and concentrations of population. Very large sums of money had to be raised and serviced so that great schemes of rock dredging, the building of piers and lighthouses and the construction of deepwater quays, wet docks and drydocks might be undertaken. Port authorities promoted bills in Parliament to obtain powers to execute such works and to raise the money by public borrowing; and, in accordance with their estimates of their increased financial burdens, they also asked for new or revised maximum charging powers. In so doing, they would have knowledge of the original and existing rates to guide them, and also of the results obtained in the past by applying such rates; and they would seek to measure the heavier annual outlay to which they were committing themselves against the probable volume of trade to be obtained.

Dues and financing.

In our day, Parliament tends to grant borrowing powers to some public bodies on the basis of redemption over sixty years in the case of civil engineering works and thirty years in the case of machinery. This consideration may be regarded as one of the several theoretical elements in the determination of some scales of tonnage dues. The permitted life of the debt and the rate of interest determine the annual servicing burden and as the money to meet it must largely be found from tonnage dues, the ideal tonnage due is that sum which multiplied by the expected average volume of trade will take care of that share of the debt incurred in the interests of shipping.

Dues, maintenance and changing values.

In addition to yielding enough revenue to cover the annual financial charges relative to facilities provided for shipping, the aim must also be to provide enough money to maintain such facilities in good repair. Annual maintenance costs are apt to be heavy, especially for such items as dredging, but manifestly the work is of cardinal importance for it is not merely the convenience but the actual safety of vessels which is involved. Given a long period of steady values, this is a matter which can be fairly well provided for in fixing the right level of tonnage dues but, over a period such as the last forty years, it has given rise to many problems. During this period, port authorities have done what they could to keep in step with the changing times by seeking extended charging powers from Parliament as opportunity has offered, and some of them have also benefited from enlarged emergency powers granted under Ministerial Orders. But there is often a time-lag in such matters and, when it is remembered that the level of wages and the prices of essential materials have now been steadily rising for a whole generation, it is probably true to say that in the case of many ports the level of dues has not risen commensurately with the true costs of maintenance.

Dues and changing trade.

It is sufficiently obvious that, even with all other things remaining equal, the dues revenue basis of a particular port's economy can be entirely falsified if a long-established staple trade is lost or seriously diminished. Thus the heavy reduction in Britain's coal export business has borne heavily upon and is still adversely affecting those British ports which have been accustomed over many years to ship coal into vessels destined for foreign countries. The loss is particularly keenly felt in trades of this kind because coal docks and coal staiths are costly to provide but peculiarly unadaptable for other traffic. The mitigating influences are (1) some increase in the coastwise coal trade (2) some increase in trades other than coal and (3) greater dues charging powers as compared with the days when the coal export trade was flourishing. But the best help of all would be the speedy recovery of the lost trade.

The element of competition.

Where two ports have overlapping hinterlands, a similarity of facilities in whole or in part and are served by equally efficient inland transportation, their tonnage dues scales will tend towards equality in respect of any vessels which they can accommodate with equal facility. Because of the many other considerations which are liable to affect such a position, this tendency may not result in absolute parity of charges but its influence will always be felt.

Length of voyage.

As has been mentioned, a particular port authority's charging powers in the matter of tonnage dues are usually stated as maximum charges; and, it may be added, most commonly in brief and simple form, though some private Acts provide a range of charges. In actual practice, however, many port authorities make a number of variations downwards according to kinds of trade. One of these variations is length of voyage. If a ship arrives from, or is proceeding to the other side of the world, the rate per register ton is likely to be higher than in the case of a coastwise vessel. The principle, in the case of the coaster, is the old-fashioned one of "little and often," but there are other considerations besides frequency and regularity. The small ship is the less costly to the port authority in the provision of facilities such as deep dredging, width of entrances and the like; and again, the port authority is somewhat guided by the test of "what-the-traffic-will-bear"—and the big ocean-going ship is earning much more freight for each voyage than is the coaster. The dues tables of port authorities are therefore frequently divided into ranges of ports, grouped in ascending order of distance from the home port and correspondingly rising in quantum.

Other variations in dues.

Besides length of voyage, port authorities commonly consider all the circumstances which have brought a particular ship to the

Port Economics—continued

port. In many places, for example, there is a particularly low refuge due applicable to vessels forced in by bad weather; a repairing due for vessels coming in only for repairs; a bunkering-only due which explains itself; and a general "not-breaking-bulk" rate which applies to ships carrying cargo but neither loading nor discharging at the particular port of call. At ship-building ports, launching dues are paid in respect of newly-constructed vessels. A ship which is accommodated at a first-class berth in enclosed docks is liable to pay more than a vessel using a tidal berth in the river; and it is probably fairly generally true that an ocean-going vessel using a dock berth or berths to discharge and also to load cargo is the highest-paying class of customer.

Tonnage dues and cargo capacity.

If a vessel discharges or loads less cargo than her own net register tonnage, it is quite common practice to allow her owner a part-cargo rebate. There are various bases of calculation, e.g. the normal rate on a tonnage corresponding to the quantity of cargo plus a special low rate over the full net register; the rebate, in such a case, being equal to the difference between the charge thus obtained and the full normal tonnage dues on the net register.

Non-discrimination.

It is usually a statutory requirement that the port authority will use the same basis of charge in dealing with all ships of the same class using the port or dock facilities for similar purposes.

Extra time or dock rent.

In most of the world's seaports, the ship's initial payment of port and/or dock dues entitles her to the use of the facilities for a laid-down period of time—say 30 days, but varying with the sort of trade, class of berth and type of port. After that period, the common arrangement is to charge a small additional tonnage due for every extra day or week. Here again, dock berthage is liable to be more expensive than accommodation at river moorings. Extra time usually arises in respect of vessels repairing, ships lying-up and new vessels fitting out.

Watch dues.

Vessels in port need protection against thieves and the danger of fire. River and dock police and a fire-fighting force, equipped with craft fitted with pumps, are maintained in many ports by the port authority—sometimes independently and sometimes in operational liaison with the civic authority. Again, it is not unknown for the watch force to be itself a statutory body entirely separate from the port authority and charging its own tonnage due on shipping in return for the protection provided.

Total expenses in port.

Those interested in the question of ships' expenses in port will do well to keep in mind that only a part—and often only a small part—of the total payment is made to the port authority, even when the port authority is also the dock authority. Other expenses commonly incurred in port include charges for pilotage, towage, boatage (men handling ropes off and on mooring buoys or quay bollards), light dues (in respect of non-port-authority lights), fresh water, stores, bunkers, discharging cargo, loading cargo, repairs, compass adjusting, fumigation and agency fees. It is true that at some places the port or dock authority supplies some of these services in addition to providing and maintaining the static facilities; but they are frequently supplied by other persons or organisations who collect the appropriate charges for them.

Cargo handling charges.

Subject to the custom of the port and unless a particular bill of lading otherwise provides, it is the normal duty of the shipowner, as part of the service to be rendered by him in return for the freight paid to him, to raise cargo to be discharged as far as the ship's rail and there offer it to the receiver. Correspondingly the shipowner must take export cargo at the ship's rail and stow it securely in his ship. As has been mentioned in an earlier chapter, port and dock authorities sometimes undertake this work, on behalf of the shipowner, in whole or in part; but in other places they confine themselves to providing the berth and the requisite equipment, leaving the actual work to be performed either by a shore organisation maintained by the shipowner, or by the principal cargo receivers, or by stevedoring firms engaged by the shipowner. Again, between the ship's rail on the one hand and, on the other, the wagons, the lorries, the transit shed or the open quay, there is cargo handling to be performed by the exporter or the receiver as the case may be. Once more, these are services which are undertaken at some places by the port or dock authority on behalf of the merchant; but in other places, he must look to cargo-handling firms to deliver his goods to the ship's rail or to receive them at that point. Lastly, when goods are destined for a warehouse in the port area, or are required to be removed from such a warehouse and sent away, the handling is usually done by the warehouse-keepers who may be the port authority or may not.

In regard to cargo-handling carried out by the port or dock authority, whether on behalf of shipowners, importers or exporters, the handling rates will naturally vary with the type of cargo, the nature of the operation, and the prevailing level of wages being paid to dock workers. In ports where there is a continuous and heavy flow of mixed general cargo, and the authority undertakes cargo work, it is not uncommon for a tariff of charges to be built up and published, rises in the level of wages being met by percentage additions. The normal aim in such rate-making is to cover the expenditure on wages, the wear-and-tear of machinery and plant, general overhead charges and the cost of supervision, and, if possible, to achieve also a modest margin of profit whilst keeping the charge reasonable. Standards of comparison will often exist in the same port and, if not, certainly in neighbouring ports which may be actual or potential competitors.

The reader is referred to pages 179-183 of the companion volume (Port Administration and Operation — Chapman and Hall) for details of types of handling charges commonly encountered, the division of port charges as between shipowner and trader and a list of typical "extra operations," relating to cargo, frequently required by traders whilst their goods are passing through a seaport or resting thereat.

Dues on goods.

As explained above, both the shipowner and the trader require port services in respect of the handling of cargo, and such services are sometimes supplied and charged for by the port or dock authority. But before the goods are touched at all they normally attract a port and/or dock charge in the nature of a cargo due. This is a statutory levy per ton (or other convenient unit) of cargo, payable by the importer or exporter, to the authority providing and maintaining the static facilities without which the goods could not be imported or exported. Levies of this nature are met with under such titles as port rate, river due, dock due, quay rate, package due, wharfage rate and a number of other names. The same ton of goods may attract more than one of such "facility" charges in the same port—according to the facilities provided and the division of their ownership and control between different authorities. If a ton of goods be brought from overseas to an enclosed public dock within the confines of a United Kingdom port, it is fairly common practice for three charges to be raised—a due in respect of the port (harbour and river) facilities, a due in respect of the dock (including dock quay) facilities, and the labourage charges for handling the goods between ship and shore. The first two are generally statutory charges subject to maxima laid down in the private Acts and are payable by the importer to the port and/or dock authority; the third charge is not statutory, is not in the nature of dues, is payable partly by the shipowner and partly by the importer, and is collectable by whomever does the work—possibly the public authority and possibly not. If the ton of goods in question goes to a public river quay instead of into enclosed docks, the same remarks apply with the substitution of a quay due for the dock due. Cases are not unknown where a given ton of goods is liable to three imposts in respect of static facilities quite apart from charges for handling. Such a case would be where the first charge is a river due (applicable to all traffic entering the port), a package due (applicable to all traffic handled at a public quay in the river) and a wharfage rate (applic-

Port Economics—continued

able to such traffic as may be landed to a public wharf or shed in the river including storage thereat for a given number of days).

Port and dock authorities sometimes differentiate in their scales of dues on goods as between export cargo and import cargo; and again as between coastwise traffic and overseas business. Differences thus made are often motivated by considerations of commercial policy and are used to give some encouragement to trades that require fostering.

When the port and dock authority undertakes cargo-handling for shipowners or traders, it is fairly common practice to include the charges for quay cranage and dock rail haulage in the labourage rate for the whole operation performed. When the authority does not act as the stevedore, it often supplies cranage and performs such rail haulage as may be required at agreed rates.

The custom of the port

The seaports of the world have a number of broad principles in common but many local peculiarities exist also. They affect such matters as the precise division of responsibility as between shipowners and traders, the supply of cargo-handling gear, the permitted speed of working, starting and stopping times, the conditions of shift-working, the manning of gangs, demurrage penalties and many more. Such features of the organisation and operational methods at particular places go under the general name of the custom of the port. It will be sufficiently obvious that this is a matter which always merits inquiry and attention on the part of port users and it is naturally in such affairs that the services of competent local agents are especially valuable to both shipowners and merchants. In our own generation, however, we have witnessed a considerable development in continuous joint consultation in port working, and it may well be that as the number and nature of clear, written agreements increases, the obscure argument from the custom of the port may progressively yield place to the interpretation and settlement of dockside problems by the light of lucid, modernised and generally comprehensible rules and conditions.

Port charges and commodity prices.

In all that has been written above, no actual figures for current port charges have been given. There is a great variety, taking the world over, but the reader will probably be interested in a few concrete examples. The port and dock authorities of the world have heavy and vital responsibilities to discharge and their membership very commonly consists of public trustees seeking no profit but striving only to serve their local communities, world trade and world shipping. From time to time, the question of port charges attracts some amount of attention and public comment; and it may therefore be valuable to include here a few of the actual charges regularly made for the use of port facilities and to note the scale of such charges in comparison with the sums of money which world traders are prepared to lay out in other directions and for other purposes.

The following table consists of 15 commodity prices published in "The Financial Times" on the 5th June, 1952; and alongside each of them is placed a figure representing combined port and dock dues obtained by averaging the dues currently in force at a number of U.K. ports :

	Price per ton £ (nearest)	Combined Port and Dock dues per ton s.	d.
Aluminium	154	5	0
Barley (Iraqian)	33	1	6
Cocoa	330	1	0
Copper	231	3	0
Copper sulphate	108		4
Iron (Foundry No. 3)	13	1	3
Lead	129	2	0
Nickel (home)	454	5	0
Oil, linseed	185	2	0
Pepper, white	1,120	6	8
Rubber	231	5	0
Sisal (No. 1)	143	2	2
Tin	977	2	10
Wool (tops)	1,372	5	0
Zinc	150	2	5

The average price per ton of the commodities listed above is £375, and the average combined port and dock due is 3s. 1d. per ton. That is to say, the charge being made by the port authorities for the use of the static facilities they provide and maintain is less than one two-thousandth part of the average price of the commodities. It could scarcely be called excessive.

As already mentioned, however, the trader also pays handling charges for services rendered; and the nature and basis of such charges has been indicated in general terms. There remains the question of port charges paid by the shipowner and a few further remarks thereon may be useful to the student.

The figures given in the following table relate to ten ports in the United Kingdom and they are taken from "Ports Dues and Charges on Shipping throughout the World," edited by S. Carter Gilmour and published by George Philip and Son, Limited, London. The ten vessels were all engaged in foreign trade—iron ore, pitwood, jute, bulk oil, generals, salt, bauxite, timber and coal. The coal was export business; all the other traffics were imported. One of the examples is a two-way trader—pitwood in and coal out.

N.R.T of Vessel	Ship's Total Expenses in Port	Total Port & Dock Dues	Discharging &/or loading cargo	Light Dues (Customs)	Pilotage	Towage	Boatage	Fresh water	Agency Fee	Petty Expenses
	£	£	£	£	£	£	£	£	£	£
2,200	982	126	683	101	13	48	6			5
1,849	1,017	260	582		32	76	16	5	37	9
973	263	127	50		21	21	8	2	21	13
1,128	381	29	247	54	15		13	2	21	
625	85	23	24		24		4		9	1
4,186	878	105	430	192	26	89	.		33	3
743	458	12	416		6				23	1
503	72	9	25		15		3	2	17	1
897	335	37	228		15	35	5		11	4
4,843	1,202	589	376		88	102	5		37	5

It is not, of course, claimed that the ten accounts given above are anything more than a chance sample, conveniently available. However, they do at least constitute a few actual illustrations of different ship's payments in the year 1950 at a number of different U.K. ports; and so far as they go, they will give the student some first ideas as to the scope and variety of the subject. The following points may be worth noting for more detailed enquiry as opportunity may offer:—

(1) There is no constant relation between the size of a ship and her total expenses in port. Some of the variable factors are revealed by the figures themselves; others include the type of accommodation (e.g. dock or open quay) and its distance from the sea, the nature and quantity of cargo and the cost of inboard handling.

(2) Neither is there any constant relation between the tonnage dues and the net register tonnage, nor again between the total dues and the total expenses in port. Tonnage rates differ as between ports (often partly because of a difference in the facilities offered) and they also differ, as previously mentioned, in accordance with ports of origin or destination. The reader will notice, however, that over the ten examples given, the amount paid in tonnage dues (that is, for the use of static facilities provided and maintained by the port and/or dock authority) varies between less than 1 per cent. and about 49 per cent. of the total expenses, and the average proportion over these ten cases is about 20 per cent.—a smaller share than is sometimes supposed.

(3) Generally speaking, the heavy single payments are in respect of cargo-handling—quite often not done by the port or dock authority at all. This is worth remembering in connection with the doctrine that it is the dues revenue which should pay for static facilities, and that without the static facilities neither ship nor cargo would be there at all.

(4) It must not be forgotten that the shipowner must meet many and continuous expenses besides his disbursements in port. These include running and manning costs, the cost of fuel, repairs and dry-dockings, surveys, insurances, depreciation and interest on capital invested. Against all these, plus his port expenses, he earns what freight he can and pays heavy taxation upon any trading profits.

(To be continued)

Handling of Cargo at European and U.S.A. Ports

Relative Advantages of Contrasting Methods Employed

By Baudirektor Dr.-Ing. HANS NEUMANN
(Chief Mechanical and Electrical Engineer, Port of Hamburg).

(continued from page 42)

Economy and number of cranes

If the practical experience derived from port operation has in our opinion shown that all cargo handling is performed faster by the use of cranes, the attempt will now be made in the following paragraphs to prove this point in detail. After all, the economical results of the facilities of a port are determined by the extent to which they accelerate the dispatch of ships calling. If, according to U.S.A. statements, the apprehension is voiced "that when a quay equipped with quayside cranes is idle an appreciable amount of capital is earning nothing" this argument will apply not only to cranes. If no ship is worked this applies equally to the quay, the sheds, the trucks and all other quay facilities, the capital investments of which lie idle.

With regard to a first rough calculation, an estimate of **capital expenditure** for the permanent facilities of the port may be made on the alternative basis of cranes being supplied or not. In this connection it will suffice to limit the calculation in extent to considering the extra expense only for the respective method of handling cargo and not the total cost for the whole length of quay.

Following what has been said before, it may, in our opinion, be accepted that the dispatch of a ship is accelerated by the use of quayside cranes. Assuming that all berths of any one port under review were fully occupied by ships, the port administration would have to take in hand the construction of new quay walls, sheds, etc. By the employment of quayside cranes they would be able to save a certain part of these expenditures. Increased output due to the use of cranes may be estimated to be 100 per cent., 50 per cent. or no more than 25 per cent. If the handling of cargo was expedited by 25 per cent. only, a berth would be used more often by an average of 25 per cent. It is easily possible to make calculations to determine the cost of one lineal metre of quay, completely finished with quay wall, roads, tracks, sheds, cranes, cargo handling gear and sundry shed equipment. (For Germany the cost amounts to about 25,000—DM.) A saving hereof to the amount of 25 per cent. produces a gain of 6,250—DM as compared with the expenditure for crane equipment per metre run of quay of 5,000—DM only. The erection of quayside cranes thus saves capital expenditure somewhere else. Such a calculation could be made without any great difficulties by any port administration with due consideration to the special conditions prevailing at their port.

In order to arrive at alternative economical results it would be useful to consider a certain stretch of quay, say of 300 m. length and 100 m. width and (for German conditions) a quay apron of at least 15 m. for the arrangement of three tracks. The calculation would have to contain the following elements of cost :

(a) **Increase of capital cost for the quay equipped with quayside cranes.**

(1) Crane equipment, the number of cranes to correspond with the density of crane equipment on other lengths of quay of the port.

(2) Raising of the shed floor inclusive of off-shore and water side platforms.

(3) Reinforcement of the quay wall to take the extra loads resulting from crane wheels plus crane rails, supply of current, etc.

(b) **Increase of capital cost for the quay to be worked by ships' gear without cranes.**

(1) Cargo handling gear (lift trucks) in sufficient numbers for the loading of railway waggons and trucks. In this connection one lift truck is estimated to be required for each 20 metres of off-shore and water side length of shed without platform. In addition a reserve of handling gear, batteries, accessories and a corresponding share of costs of battery loading station or fuelling station respectively.

(2) Pallets for each lift truck for interim storage of goods in the shed, 200 pallets being considered a minimum per lift truck since, according to U.S.A. statements, an average of 700 pallets is provided per lift truck.

(3) Mobile cranes for the handling of cargo into and out of harbour barges and inland water craft, 5 mobile cranes being considered as sufficient equipment for a shed of 300 m. length.

(4) Paving of quay apron by concrete or reinforced concrete slabs suitable for truck traffic.

(5) Increase of shed area for truck traffic inside the shed and for storage on pallets.

(6) Additional length of quay (in accordance with above estimate 25 per cent. ought to be taken into account) to make up for the slower dispatch by ships' gear.

[Photo by courtesy of Mersey Docks and Harbour Board.

View of the Port of Liverpool showing roof cranes on transit sheds (note greater length of crane jibs plumbing the quays and shorter lengths of crane jibs at rear of sheds, and ordinary portal quay cranes on extreme right).

Handling of Cargo at European and U.S.A. Ports—continued

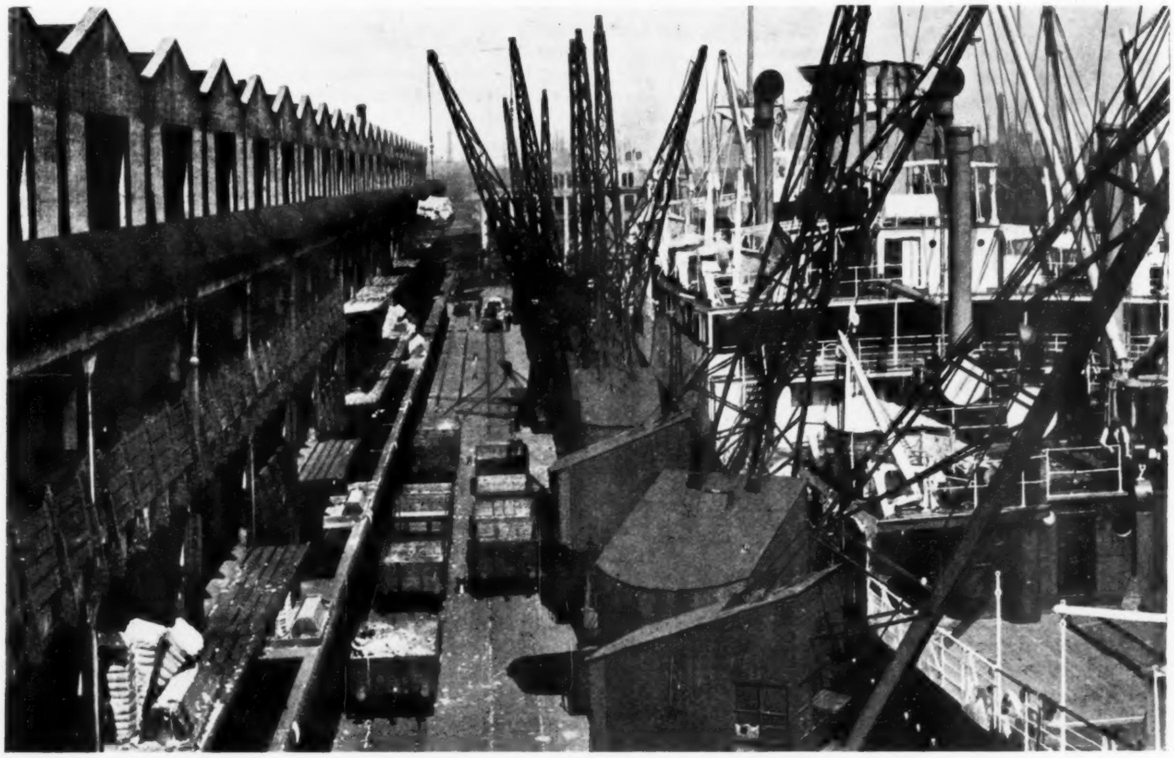
The expenses corresponding to any one port may now be inserted in such a rough calculation. Variations to suit local harbour practice in regard to equipment are of course possible in one way or another. For Geman ports this rough calculation showed an increase of about 100 per cent. for a length of quay of 300 metres alone in increase, for handling without cranes, in capital investment charges, and without consideration of operational advantages or disadvantages. Further it must be assumed that in case of alternative (b) operational costs will be higher since expenses for maintenance, repair and fuel for lift trucks plus pallets and mobile cranes will no doubt amount to greater costs.

When looking at the whole problem from the ship's point of view the economic advantages of a port arising from its equipment with cranes may well be illustrated by the following example:

Some years ago a German shipping company was planning an increase of its North Atlantic service. It was proposed to supplement the four vessels of a certain class by building a fifth unit. They would, however, be in a position to do without this new construction if it were possible to reduce the time of the round trip of each of the four vessels by 7 days. Part of this saving in time was to be achieved by a shortening of the time in port, of equal duration in the ports of Hamburg and New York. Careful investigations led to the conclusion that a reduction of time in port at Hamburg of 5 days would be attained by converting existing cranes of the fixed jib type into luffing cranes. Thus it would be possible to employ a considerably larger number of cranes per ship. Contrariwise no shortening of time could be achieved at New York since an increase of output by ships' gear was not feasible. However, two days at sea could be saved by structural changes to the hull. Thus the port equipped with quayside cranes was able to offer the possibility of saving an expense of 18,000,000 marks for a new vessel as compared with an outlay of about a quarter million marks expended on a further improvement of its facilities.

Similar considerations may be applied to the cargo ship proper. The operation of a vessel of e.g. the Liberty type costs inclusive of the crew's wages about $2,500 per day. It is possible to accomplish the dispatch of a ship in ports equipped with quayside cranes, as opposed to those relying exclusively on the employment of ships' gear, so much faster that the ship will be at sea 20 days more per year. This alone would result in a saving of $50,000 approximately.

The economy of the total cargo handling facility will be decisively determined by selection of the right **number of quayside cranes.** If there are too many, capital expenditure will lie idle. In case of too small a number of cranes, sea ships will have to await dispatch, thus causing increased expense on this side. In the case of free competition and under otherwise equal conditions the ship owner will give preference to the port which offers the fastest dispatch. The question of equipping quays with the proper number of cranes can therefore be solved in the different ports by the experienced harbour expert only. In this connection, however, he will have to take into account the tradition, practice and any special handling requirements of the port. Without precise knowledge of local conditions it would therefore be difficult to compare critically the number of quayside cranes existing in the many different ports.



[Photo by courtesy of the Manchester Ship Canal Company.

Cotton being discharged direct to five-storied transit shed by quay crane at the Port of Manchester. Note (1) fixed verandah on first and fourth floors; (2) hinged platforms on second and third floors; (3) ship's gear rigged for dragging bales into square of hatch.

The number of cranes is essentially determined by the need to work a ship loading and discharging as fast as possible in order to get it to sea again. The type and dimensions of the seagoing ship, number and size of hatches, nature and amount of cargo, the requirement of transferring cargo into inland water craft, the use of floating cranes or mobile cranes and consideration of cranes obstructing each other will determine the proper number of cranes. Furthermore we must take into account the amount of cargo to be handled across the quay in relation to the total volume of cargo and the demand for shed space resulting therefrom, the width of the quay sheds, and the demand for simultaneous working of cargo into inland water craft (this frequently due to lack of shed space).

The density of crane equipment is furthermore dependent on the respective length of quay, long quays requiring less cranes per

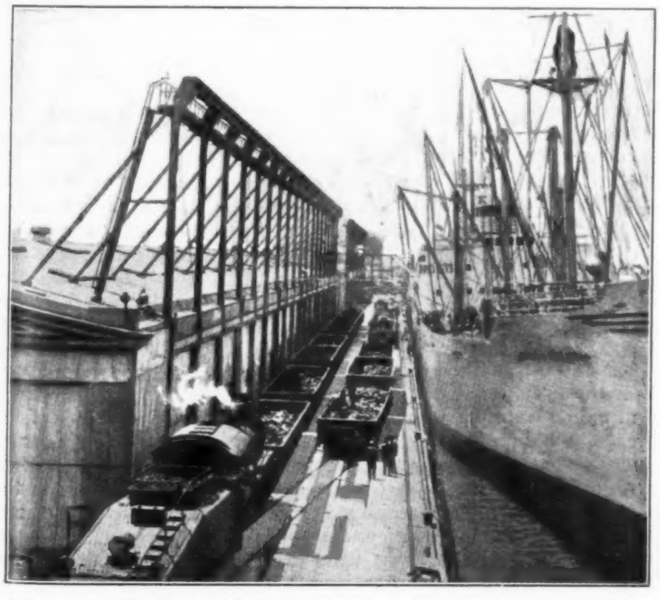
Handling of Cargo at European and U.S.A. Ports—continued

shed unit than short quays because the cranes may be massed in accordance with requirements at points of maximum handling demand. Consequently the density of crane equipment varies not only from port to port but quite frequently also from quay to quay at the same port. In this connection it may be assumed that the luffing cranes has gained a definite lead over its competitors and that its greater flexibility permits the use of a larger number of cargo hooks working into one hatch. The heterogeneity of the above-mentioned factors does not allow of determining the number of cranes by mere calculation or to lay down a formula for equipping a quay with them. Any attempt in this direction is bound to fail because one would have to set out from assumption which vary completely in each different case.

Consideration must be given to the possibility of simultaneous working of sea ships and inland water craft and for providing a certain reserve in case of failure of cranes. Furthermore the management will try to arrange cargo handling operations in such a way as to avoid as far as possible two continuous berths requiring simultaneously the maximum of crane assistance, thus making the best use of the mobility of modern cranes by providing a maximum to one ship first and then to the other.

Again it must be emphasised that the development of ship building will advance continuously during the useful life of a crane. In this connection the tendency is evident to build ships of ever increasing length and larger draught. Since the ship's capacity grows proportionally to the third power of the ship's length the number of cranes per ship will have to be increased continuously. According to Hamburg port statistics, the number of quayside cranes had to be tripled within fifty years as against a twofold increase in the average length of sea ships handled at quay sheds. To meet this requirement the number of cranes had to be increased by new units in the course of the years. On the other hand it is manifest from what has been said above, that for purposes of comparing crane equipment in different ports only ports handling similar trade can be related to each other, and that ports handling ships of smaller average size cannot be compared directly, e.g. with the large ports of the North Sea handling a big overseas trade.

When planning crane facilities, the operators and engineers will soon pass from a calculative to an empirical solution of the problem. Experience of many decades will set the pace for future planning. The example of Hamburg may show what kind of considerations have been taken into account. In order to work larger vessels with 5 to 6 hatches and a full cargo, 10 to 11 cranes will be employed, in the Port of Hamburg, in exceptional cases up to 13 cranes. Assuming a ship's length of 130 to 150 m. this would mean a density of one crane per 10 to 15 m. of length of quay. Newer shed constructions in Hamburg of 400 m. length and 50 m. width are built to provide two berths, sufficient space being left for the simultaneous handling of inland water craft. Considering the exchangeability of the cranes, a minimum number of 8 cranes is required per berth. If lighters are to be worked simultaneously the number of cranes per ship will have to be reduced correspondingly. This leads to a minimum of 16 cranes for a shed of 400 m. length and a density of equipment of one crane every 25 m. of length of shed. It is advisable to relate the number of cranes to the length of the shed and not to that of the quay.



View of Burtoning " Masts " erected on roof of single-storey transit shed at a typical U.S.A. port.

It is in the interest of good economy to make still better use of existing facilities and therefore to increase the output per unit. The average amount of cargo handled per year and per square metre of shed space is a good measure of the intensity of cargo handling operations. According to Hamburg statistics 9 to 10 tons per year and per square metre of shed space were handled, with a peak of 21 t/sq. m. A comparison made for several sheds of equal size but with varying crane equipment showed that where the number of cranes was higher by one third the productivity of the sheds, rated in t/sq. m. and year, increased equally by one third, provided handling operations were smooth and fast. It can be proved by calculation that the share of fixed costs for engineering and mechanical quay facilities in relation to one ton of cargo handled decreases by 20 per cent. if the number of cranes is increased by one third. An increase of cranes up to the maximum commensurate with the largest tonnage of cargo to be expected will therefore still justify the increased capital investment. A similar economic calculation may be made for any type of handling operations under review.

An investigation made by the author in 1950 with regard to the crane equipment of 40 sea ports in Europe and North Africa showed that the equipment of ports with cranes is arranged on rather contrasting lines. A particularly extensive crane equipment is to be found, with a density of 18 to 25 m. of length of shed per crane, in German, Scandinavian and in some British, French and Italian ports. Other large ports, with heavy inland water traffic, have increased their handling capacity by the provision of numerous floating cranes. At Rotterdam besides 235 quayside cranes altogether 102 floating cranes are used. In ports with closed docks and stable water levels, conditions were favourable for the use of a large number of mobile cranes. In this type of port the crane density will be found to be one crane per 25-35 m. length of shed. On quays with a heavy traffic via the shed and uniform use of cranes when working ships the employment of electrically-driven quayside cranes will be found to be more economical than mobile cranes which always have to carry their own power plant (mostly diesel, in some cases steam).

The proper number of cranes for the handling of general cargo at quay sheds will have to be investigated for each case independently. Competition between sea ports may bear a decisive influence on the correct solution of this question.

Conclusions

On account of completely different conditions regarding the respective layout and engineering facilities, as also because of dissimilar economical and operational considerations in respect to cargo handling technique, a comparison of crane equipment in European and North American ports does not admit of a fair judgment of their relative merits. The problem was to investigate why European ports use quayside cranes and whether it is expedient to follow the example of North American cargo handling technique.

This question can also be put as follows: " Does the quayside crane increase the capacity and economic efficiency of a sea port?" In our opinion this question is answered in the affirmative as a result of the above investigation. European sea ports cannot do without the assistance of cranes for the following reasons:

(continued at foot of next page)

Dock Labour in the United Kingdom

Summary of Fifth Annual Report of N.D.L.B.

The fifth Annual Report of the National Dock Labour Board was issued early last month, and in the foreword to the report it is stated that the position has changed considerably since the turn of the year, and the Board now finds itself in a position in which it is carrying large surpluses of labour. This factor, coupled with the increased costs due to new holiday and wage rate agreements, means that the Board has been operating at a deficit. The Board has taken the necessary steps of stopping new recruitment of dock workers, and of increasing the general rate of percentage payments to $13\frac{1}{2}$ per cent. in order to deal with the adverse balance of the budget for 1952.

Labour Force.

Dealing with the size of the labour force, the report states that employment in the docks in 1951 was higher than in any of the 10 years since Dock Labour Schemes were first set up. To meet a heavy import and export programme the labour force, which had reached over 75,850 men in 1950, was increased to a new high level of 82,500 by the end of November, 1951, with an average of 80,088 men over the year. In certain ports, however, the supply of suitable candidates for admission to the register was insufficient to meet both the authorised additional recruitment and the replacement of losses due to normal wastage.

In permitting recruitment to the Main Register—particularly in times of peak employment—the Board must have regard to the numbers of men for whom a reasonable amount of continuous employment was likely to be available. That was a vital factor involving problems of considerable difficulty, on which depended not only the efficient turn-round of ships but the avoidance of serious redundancy when the peak was passed.

In the conditions obtaining in 1951, it was therefore encouraging to note the increasing use made by Local Boards of Temporary Registers to deal with abnormal traffic. The Board also welcomed the growing tendency of some Local Boards to fill vacancies on the Main Register from among men who had given satisfactory service in a temporary capacity. Discrimination of that kind by Local Boards—i.e., in favour of men of proved calibre—was clearly valuable to the Board in its efforts to improve the quality of the labour force. Local Boards had also co-operated to this end in the continuous review of workers' grouping, and in controlling the age of admission to the register. As a result, a census of the Workers' Register at 31st July, 1951, showed a significant reduction in the number of Group "C" men, and a lowering of the average age of daily workers from $46\frac{1}{2}$ to $45\frac{1}{2}$ years, as compared with the previous year.

The training of certain types of specialist workers, which the Board had continued to assist and encourage, assumed greater significance with the expansion of the labour force to meet the increasing volume of work. Payments to workers during the year included £5,917 paid by the Board for the training of 326 registered men and of 114 lighterage apprentices who will ultimately enter the Board's registers as licensed lightermen. Of the 326 men trained, 299 qualified for employment as checkers, crane drivers, putters out, etc., but an undue number were subsequently lost by resignation. The Board was concerned at such losses which adversely affect the efficient manning of vessels; and ways of overcoming this trend are under consideration.

Costs of Operation.

The size and quality of the labour force in relation to available employment are two of the principal, but not the only factors affecting the turn-round of ships. The efficiency with which the Board handles matters of labour supply and its other duties under the Scheme have also a material bearing on the speed of turn-round; and all these factors have their individual and conjoint effect on the Board's finances. In spite of :—

(a) the substantial increase in the registers;
(b) the higher rates of pay which correspondingly increased holiday pay and certain transfer costs;
(c) increased contributions to National Insurance; and
(d) the effect of rising prices on other items of expenditure;

the Board's operational (excluding Welfare and Capital) costs were some £60,000 lower in 1951 than in the previous year.

This saving on operational costs was entirely attributable to the exceptionally high volume of dock work throughout the year, providing employment for an average of over 63,500 men or more than 79 per cent. of the average Workers' Register of 80,088 men. The consequent drop in the average number of men proving attendance —from 6,924 men in 1950 to 4,805 in 1951—resulted in a saving in expenditure on attendance money and guarantee make-up of nearly £350,000, equivalent to a levy of over 1 per cent. on the wages of daily workers.

Apart from the foregoing factors, which were directly affected by fluctuations in the level of employment, the pattern of the average distribution of labour varied only within narrow limits. Excused attendances showed a decline and satisfactory explanations were subsequently received in respect of many men who could not be accounted for at the call time; and it may, therefore, be fairly said that voluntary absenteeism is not a serious problem.

Strikes and other stoppages during 1951 involved an average of $1\frac{1}{2}$ per cent. of the Workers' Register, against only $\frac{1}{2}$ per cent. in 1950. Of the 339,878 man/days lost, over 330,000 (of 98 per cent. of the total) were lost in three ports, i.e. London, Liverpool and Manchester; and over 211,000 (or 62 per cent. of the total) related to disputes over the National Docks Agreement of 5th February, 1951.

There was a marked increase in the numbers of transferred labour over the previous year; daily transfers totalled 840,403 man/days, and period transfers about 14,596 man/days. Partly because of the greater numbers, and partly owing to higher transport charges and allowances to workers, transfer costs rose from £136,141 in 1950 to £179,209 in 1951. There also was a notable increase in the average number of non-registered workers employed to meet short-term peaks—usually of a few days' duration.

These measures, however, were insufficient to cover employers' requirements; nor could such a goal be achieved except at a prohibitive cost to the industry, and by unjustifiable inroads on the national man-power. The size and persistence of labour shortages

Handling of Cargo at European and U.S.A. Ports

(continued from page 91)

(1) European sea ports require a wide quay apron between the edge of the quay and the shed wall for the dispatch of voluminous railway and truck traffic. The quayside crane, by lifting the ship to shed (or transversal) load in a higher plane obviates interference with the longitudinal traffic on the quay.

(2) The quayside crane covers a considerably larger area on the quay. It facilitates the use of platforms on the water side of the shed if they should be found advisable for operational reasons. Hereby lifting labour is saved.

(3) The necessity of working inland water craft which to a large extent is non-existent in the ports of the United States makes crane assistance indispensable in European ports.

(4) A large part of the ships' gear is required in European ports for the important handling of cargo on the off-shore side between ship and inland water craft, therefore no longer available for working cargo ashore.

(5) In most European ports changing water levels due to rise and fall of tide play a part which should not be overlooked. This circumstance renders all handling by ships' gear uncommonly difficult.

(6) In respect of the output per gang, where ships' gear is used, being equal or larger than that of quayside crane work the total handling output—and this alone is decisive—is larger if cranes are used because a considerably higher number of gangs may be employed per sea ship. Slower dispatch of ships in port means that more berths with all their appurtenances have to be held available in order to keep the port handling capacity at the same level.

In our opinion it is the quayside crane that, in European ports, is the most appropriate means of answering all problems arising from the many requirements of cargo handling.

Dock Labour in the United Kingdom—*continued*

—particularly in the first and third quarters—were a source of recurring anxiety to the Board. Yet, by the end of the year, it was clear from the falling shortages and rising surpluses of labour that resistance to some of the local pressure for additional recruitment had been justified.

Earnings of Daily Workers.

The gross earnings of daily workers averaged £9 16s. 6d. a week compared with £8 12s. 10d. in 1950. It was estimated that the average increase was due, in almost equal proportions, to the increased rates of pay and the exceptional employment available. The total earnings of registered dock workers consequently reached a new high record of over £38¼ million, of which £31½ million was paid to daily workers and £6¾ million to registered weekly workers.

Welfare.

Seven new medical centres were opened last year, at Bristol, Cardiff, Greenock, London (Royal Albert Dock and West India Dock), Middlesbrough and Southampton—making a total of 31 centres open in 16 ports. Six further centres and three First Aid Rooms were under construction at the end of the year. The number of treatments increased to over 240,000, of which more than half were to registered dock workers. The Board has agreed with the National Joint Council a policy for medical services in small ports; and a preliminary survey of the conditions and requirements in the appropriate areas was in preparation at the end of the year. The expansion of the Board's Medical Service is reflected in the higher maintenance costs of £64,113, compared with £43,056 in the previous year.

Several groups of employers agreed to contribute towards the cost of treatments given to their non-registered employees at the Board's Medical Centres. Among these were Port Authorities who also agreed that, where Medical Centres are built on dock property, the sites should be leased to the Board at a nominal rent — a valuable concession for which the Board recorded its appreciation.

Education.

Local or regional Week-end Schools, for which the demand was increasing throughout the country, were held on six occasions during the year and reached their culmination in the first National School for dock workers held at Exeter College, Oxford, in June. Further grants were made, mainly to Liverpool dockers, in respect of two weeks' residential courses on Port Working at Burton Manor College, Cheshire; and new ground was broken by awarding bursaries to two workers attending full-time courses in Social Science and Administration at the University of Liverpool.

Under the auspices of the Institute of Transport, classes for the study of port operations were started in many ports. The Board co-operated with the National Joint Council, the Dock and Harbour Authorities Association and the Docks and Inland Waterways Executive in launching this project and more than 600 dock workers enrolled for the first winter's course.

Financial Policy.

Early in 1951 it became clear that the higher volume of employment and increased rates of pay would raise the yield of percentage payments, even at the reduced rates introduced at the beginning of the year, substantially beyond estimated expenditure. To avoid this and to give the industry the relief to which it was clearly entitled, the rates of levy were again reduced on 28th April as follows :—

Daily Workers employed on work other than Coastal Traffic	from 13½ to 11%
Daily Workers employed on Coastal Traffic, as defined	from 9 to 7½%

The levy on the wages of weekly workers remained at 3 per cent.; and appropriations for Welfare from the foregoing rates were continued at ½ per cent. on the wages of both daily and weekly workers. This further adjustment of percentage payments was estimated to reduce the Board's income by £490,000 in 1951 and by £728,000 in a full year. The actual income from percentage payments was £3,678,850.

The accounts show that excess of income over expenditure on the management fund was £662,928 as compared with £861,558 in 1950. Income totalled £3,690,558 (£3,948,690) and was made up of employers' percentage payments £3,678,850 (£3,940,943); employers' contributions in respect of weekly workers employed in other than dock work £3,994 (£4,499); interest received £4,376 (£1,962) and sundry credits £3,338 (£1,286).

Expenditure was as follows: Amounts payable to workers' attendance money £673,857 (£979,021); make up to guaranteed minimum £36,238 (£79,428); annual holiday pay £460,651 (£393,189); public holiday pay £385,786 (£333,744), transferred men £106,850 (£74,736); training schemes £5,917 (£3,981); conveyance of transferred men £72,359 (£61,405); national insurance (board's contribution £674,607 (£635,693); administration and general expenses £611,363 (£525,835), making a total of £3,027,630 (£3,087,132).

Permanent International Association of Navigation Congresses

Report of the British National Committee

The Annual Report for 1951/52 of the British National Committee of the above Association states that three meetings have been held since the last Annual General Meeting held in June, 1951. The Committee has been instrumental in obtaining Papers as follows for the next Congress to be held in Rome in 1953—this list is not final as the Committee is continuing its efforts to obtain additional Papers:—

Section I—Inland Navigation

Question 1.—Waterways subject to heavy floods and large variations of water level—Mr. J. T. Evans.

Section II—Ocean Navigation

Question 2.—The impact produced by ships when berthing more or less heavily; forces produced by wind and currents; the results of the impact on fenders and on the mooring appliances both of the ship and of the structures; the means of minimising these effects—Prof. A. L. L. Baker.

Ocean Terminals—Mr. M. G. J. McHaffie.

Communication 1.—Measures against the corrosion and deterioration of the various construction materials with special reference to the lower parts of wharves, quays, etc., in deep water—Mr. C. W. N. McGowan.

The question of increasing the membership of the British Section has been receiving the attention of the Committee and a circular letter setting out the objects of the Association and of the British Section has been sent to those Harbour Engineers and Authorities who are not members. In this connection it is worthy of note that the total membership in Great Britain is 58 compared with 677 in the United States of America; 238 in France; 150 in Spain; 146 in the Netherlands; 135 in Italy; and 132 in Belgium.

The attention of the professional institutions in Canada, South Africa, Australia and New Zealand has been drawn to the activities of the Association. A similar approach was made to the Colonies, through the medium of the Colonial Office, and, so far, five Colonies (Nigeria, Gold Coast, the Gambia, Uganda and Malaya) have expressed a desire to join the Association.

During the year the Institution of Civil Engineers has continued to provide, without charge, the secretarial facilities for the British National Committee and to accept, on behalf of the Brussels Headquarters, subscriptions from members in the United Kingdom.

New Lightening Berth for West Hartlepool.

The Government has granted a licence for a new lightening berth at the Port of West Hartlepool to cost £330,000. Service sidings are to be constructed immediately, and work on the new berth is likely to begin in October. Disclosing this development during a visit to the Hartlepools last month, Sir Reginald Hill, chairman of the Docks and Inland Waterways Executive, said West Hartlepool was an old port and ships to-day were bigger than those for which it was built. When ships could lighten at the new berth and afterwards continue their discharge in the other docks, then to a large extent, the future of the port's timber trade was assured.

Manufacturers' Announcements

New Mobile Crane

The "Staffa" 2-3 ton mobile crane, designed by Chamberlain Industries Limited, Staffa Works, London, is of extremely robust construction and especially suited for general industrial use and work on airfields, building sites, dockyards, etc.

The crane has been specially constructed to reduce maintenance to a minimum, and to ensure that, where maintenance is inevitable, it will be of a simple mechanical nature. An outstanding feature is the provision of a robust hydraulic ram for raising and lowering the jib. Motion is controlled

by a conveniently placed lever operating a valve which is completely enclosed within a generous oil reservoir. This finger tip control mechanism gives easier and safer control of derricking operations. An engine driven hydraulic pump supplies the power and the ram unit is safeguarded from failure by means of a specially developed non-return valve.

The hoisting mechanism comprises a fan-cooled worm reduction gear, upon which is mounted the grooved drum conveying 65-ft. of ⅝-in. dia. construction wire rope. Power is transmitted by a propeller shaft and chain drive from a special marine type forward and reverse box, situated at the rear of the crane and coupled by a further propeller shaft to the engine.

The crane itself is powered by a Newage-Austin industrial type o.h.v. petrol engine of 1200 c.c. capacity and developing 15 b.h.p. at 1800 r.p.m. The petrol tank has a capacity of approximately 9 gallons. Transmission is from a single dryplate clutch and synchromesh gear box, providing four speeds forward and one reverse.

Mechanically operated internal expanding brakes are fitted to the front driving wheels and may be actuated by foot pedal or hand lever.

The two steering wheels are trunnion mounted and can be turned through 150 degrees, providing an extremely small turning circle, within the crane chassis length. The twin front wheels and rear steering wheels are fitted with six pneumatic tyres.

The chassis, which is of all-welded construction, is fitted with a front bumper plate to give maximum protection to tyres and wheels and also to push loads or vehicles if required.

New Fork-Lift Truck

The 1-ton Matbro is the finished product of an entirely new conception of light-weight fork truck construction and opens up new fields of usage hitherto closed to similar vehicles of this size and weight.

Essentially it is an all purpose truck equally suitable for working in the confined space of a factory floor or loading bay, or traversing rough ground and difficult gradients. This capability of being able to perform a dual role by working over both rugged and smooth surfaces enables a user to handle a load in any small storage area or workshop space and on open sites. The truck, being suitable for both indoor and outdoor operation, offers one major advantage to persons contemplating a programme of palletisation, making it possible to limit capital expenditure by obviating the necessity of purchasing two or more vehicles to accomplish what can be done in only one operation.

The secret of this double-purpose combination lies largely in an ingenious "return-drive" from the engine to driving axle, which enables the truck to be of short dimension whilst having every advantage of the large size wheels and tyres used.

One of the main reasons for its ability to work on any surface conditions lies in the use of large diameter pneumatic tyres, all three wheels being fitted with 7.00 x 16 wheels, giving an overall diameter of 31-in. This is the first time that large size wheels have been fitted to a 1-ton fork truck, making it suitable for outdoor use.

This truck which is built by Matthew Bros., Wallington, Surrey, has been designed for maximum efficiency with minimum size, being only 84.5-in. long, less forks, with a track width of 46-in. and a ground clearance at the lowest point of 9-in. The degree of manœuvrability offered is due to the new-type steering, for which a patent has been applied. This gives the truck a turning radius of only 75-in., the rear wheel fork turning through an angle of 127° at full lock.

Of the two models made, one has an up to 9-ft. operating height, giving a floor to mast-top distance of 89-in. at the lowest position and 131-in. fully extended. The other type will operate up to 12-ft., and has minimum and maximum mast heights of 107-in. and 167-in. respectively. Both mast assemblies are of the roller type, thereby eliminating sliding contacts, lifting being effected by an hydraulic cylinder in conjunction with flexible steel wire ropes.

The power unit, which drives the front two wheels, is the 10 h.p. Ford industrial engine, and is sited so that both engine and transmission can easily be removed without disturbing the hydraulic system in any way. This absolute accessibility to all parts of the transmission allows a considerable saving of time on any repair work undertaken, in adidtion to making such work far easier to carry out as engine, gear-box and driving axle can each be taken down as an independent unit. The transmission comprises three forward and one reverse speed through a selective type gear-box with synchromesh on second and top.

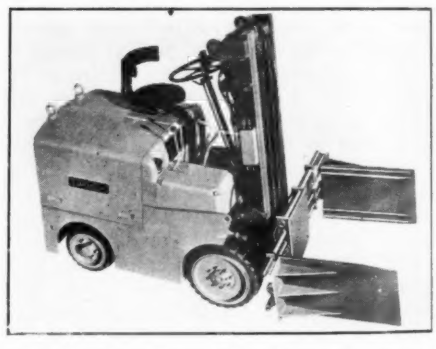
On a normal metalled surface, the truck is capable of travelling at a speed of 15 m.p.h. and can tackle a gradient of 1 in 6 with full load over rough ground. In addition to the standard forks, a range of additional attachments is available; these provide a diversity of uses to which the truck can be put.

The bucket-shovel is ideal for loose material handling, and for lifting and moving awkward shaped or bulky objects such as vehicle engines, an attachment is available which transforms the truck into a mobile crane for indoor or outdoor use. It consists of a joist and channel with an adjustable crane hook, the position of which is easily changed to suit the outreach and load. There is also a boom, which is used for handling coiled materials.

New Grab Device for Mechanical Handling

Messrs. I. T. D. Limited (Industrial Truck Development) of Ladbroke Grove, London, W.11, are the manufacturers of a comprehensive range of fork-lift trucks having load capacities from 1,000 to 5,000 lb., and lifting heights from 6-ft. to 14-ft., on chassis powered with diesel, petrol or battery electric units.

All of these fork lifts can be fitted with a variety of special ancillary equipments which are used to convert the conventional fork-lift truck into a number of specialised materials handling "tools."



Of special interest is the "Stacatruc" battery-powered model fitted with a Rodman grab device. This equipment enables a movement of the grab arms, ranging from approximately 16 to 60 inches, and the load carrying capacity is 1 ton. It is claimed that the new device is invaluable for many operations involving the movement of bales, packing cases and drums, rendering the use of pallets unnecessary.

Messrs. Small & Parkes, Ltd., of Manchester, announce that the 23rd of a country-wide chain of DON service depots, where the usual facilities to the trade, including brake and clutch plate relining on the premises are available, was opened recently at 50, Old Market Street, Bristol (Telephone: 27214).

PUBLIC APPOINTMENTS.

SUDAN GOVERNMENT.

SUDAN RAILWAYS require a Harbour Engineer, aged 35 to 45, for service in the Sudan on Harbour construction and maintenance.

Applicants should be Associate Members of the Institute of Civil Engineers or hold an Engineering degree recognised as exempting from Sections A and B of the A.M.I.C.E. Examination, and must have had specialised training and experience of Harbour construction and maintenance.

Appointment will be on probation for Short Term Contract (with bonus) for up to five years in the salary range £E.1525 to £E.1975 per annum. A starting salary higher than the lowest rate may be given if justified by age, qualifications and experience. A cost of living allowance may also be payable. Free passage on appointment. There is at present **No Income Tax** in the Sudan. Outfit allowance of £E.50.

Further information and application form will be sent on receipt of a postcard only addressed to The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting "Harbour Engineer 1909" and name and address in **block letters.**

SENIOR CIVIL ENGINEER with experience in dock and harbour construction required for overseas. Salary £1,700 per annum plus cost of living allowance. Apply, stating age and experience: Box No. 140, "The Dock & Harbour Authority," 19, Harcourt Street, London, W.1.

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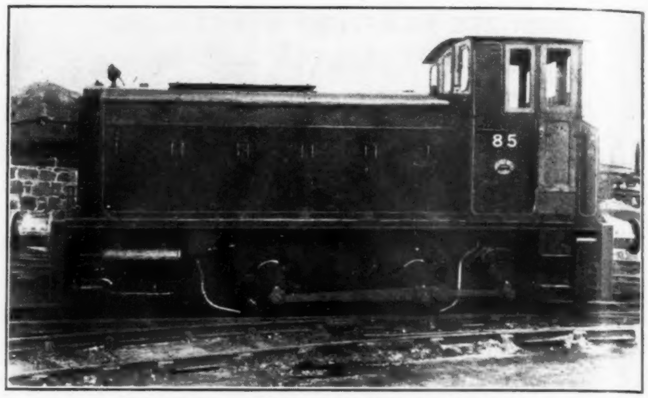
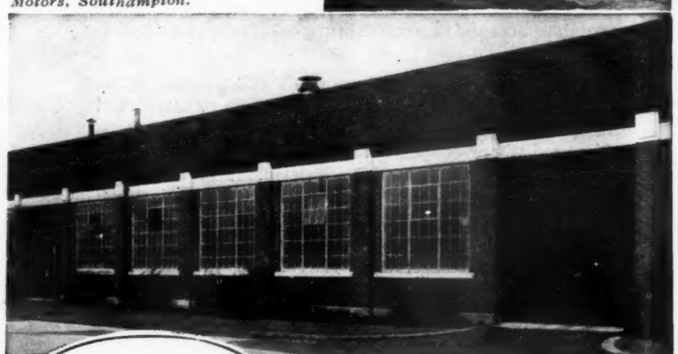

85



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